THE GAS JOURNAL

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Vol. 197 84th Year No. 3584

A Glance at the Contents

Costing in Gas Undertakings.

Major R. N. Barnett, Chief Accountant to the South Metropolitan Gas Company, deals with mechanical methods of costing. [p. 201.]

Pipe Making in Oldham.

A development of industry in the Oldham district is of interest to the Gas Industry. Messrs. Platt Bros. & Co., Ltd., have commenced the manufacture of gas mains. [p. 190.]

Atmospheric Pollution.

The causes, effects, and remedies of atmospheric pollution were the subject of an address to the Scottish Junior Gas Association by Mr. T. M. Ashford, Senior Smoke Inspector, Public Health Department, Glasgow. [p. 204.]

Water Softening Plants.

Operating costs of the lime-soda plant, zeolite plant, and the continuous blowdown system are given by Mr. J. C. Cotterill, of Worcester, who describes the last-named system as the most modern and economical method of water softening yet devised. [p. 205.]

Intermittent Chamber Ovens.

We conclude our extract of the paper by Mr. L. H. Sensicle at the Third International Conference on Bituminous Coal, held at Pittsburg in November last. [p. 199.]

Development of Gas Fires.

A correspondent describes a gas fire which, in addition to radiant heat, yields a measure of convection. The radiants of this appliance are inclined forwards. [p. 187.]

Factory Illumination.

A synopsis is published of an address on "Factory Illumination in Relation to Safety" by Mr. J. S. Dow at a meeting of the Industrial Section of the London "Safety-First" Council. [p. 200.]

Naphthalene Removal.

In an extract of a thesis which gained for the author the Diploma of the Institution of Gas Engineers, Mr. B. Thorpe, of the Huddersfield Gas Department, shows that the regeneration of the oil used for naphthalene washing is fully capable of justifying itself by the saving in gas oil cost to such works as are not able to use it for gas making. [p. 196.]

Forthcoming Engagements

Jan. 29.—LONDON AND SOUTHERN DISTRICT JUNIOR ASSOCIATION.—Meeting in London. Paper by Mr. Roy Summerson, "Exhausting and Governing Gas from Retorts."

Feb. 4.—MIDLAND JUNIOR GAS ASSOCIATION.—Meeting in Birmingham. Paper by Mr. A. Whitehouse.

Feb. 5.—LONDON AND SOUTHERN DISTRICT JUNIOR ASSOCIATION.—Annual Dinner.

Feb. 5.—SCOTTISH JUNIOR GAS ASSOCIATION (EASTERN DISTRICT).—Visit to Messrs. Alder & MacKay, Ltd., Edinburgh.

Feb. 6.—MANCHESTER AND DISTRICT JUNIOR ASSOCIATION.—Visit to new works at Lostock Road, Preston. Paper on "Industrial Gas Furnaces" by Mr. G. H. Windiate, of Stretford.

Feb. 6.—SCOTTISH JUNIOR GAS ASSOCIATION (WESTERN DISTRICT).—Paper by Mr. J. Leckie.

Feb. 8.—INSTITUTION OF GAS ENGINEERS.—Finance Committee, 2.30 p.m.; Executive Committee, 3 p.m.; 28, Grosvenor Gardens, S.W. 1.

Feb. 8.—MIDLAND ASSOCIATION.—Annual Dinner and Dance, Grand Hotel, Birmingham, 6.30.

Feb. 9.—INSTITUTION OF GAS ENGINEERS.—Council, 10 a.m.; Education Executive Committee, 4 p.m.; 28, Grosvenor Gardens, S.W. 1.

Feb. 13.—MIDLAND JUNIOR GAS ASSOCIATION.—Visit to the Frankley Works and Reservoir of the Birmingham Water Department.

Feb. 19.—LONDON AND SOUTHERN DISTRICT JUNIOR ASSOCIATION.—Meeting in London. Paper by Mr. J. H. Escreet.

Feb. 19.—INSTITUTION OF CHEMICAL ENGINEERS.—Annual meeting in London.

Feb. 20.—YORKSHIRE JUNIOR GAS ASSOCIATION.—Visit to Bingley. Paper by Mr. G. A. Winfield.

Feb. 25.—JOINT JUNIOR GAS ASSOCIATIONS.—Visit to British Industries Fair, Birmingham.

Feb. 26.—JOINT GAS SALESMEN'S CIRCLES.—Visit to British Industries Fair, Birmingham.

March 1-3.—Joint Conference of the Society of British Gas Industries, British Commercial Gas Association, Institution of Gas Engineers, and National Gas Council, British Industries Fair, Birmingham.

EDITORIAL NOTES

The Spiral Gasholder

READERS will welcome, in this issue of the "JOURNAL," the first instalment of a brief treatise, by a recognized authority like Mr. S. M. Milbourne, A.M.I.Struct.E., investigating from a mathematical standpoint, as far as possible, the main loads and stresses induced in the various members which constitute the spiral-guided gasholder. The significance of accurate determination of the stresses in such large and important structures as spiral holders cannot be over-estimated, and it is therefore hoped that Mr. Milbourne's treatise may be of great use to those engaged in the design and maintenance of this plant.

The series will comprise some five or six articles, which we are pleased to have secured, as a valuable addition to our technical matter, for publication in the pages of the "JOURNAL." Though we have printed from time to time papers dealing with the stresses in spiral-guided holders, so far as memory serves no systematic investigation of the main loads in the various portions of these structures has been published in our pages.

A feature of the present treatise is that the modern and now generally accepted view of the manner in which the wind operates on circular objects has been introduced, and its influence on the different parts of the holder has been clearly defined. When spiral-guided holders were first introduced, it was generally considered that the system of guiding was of such a character as to render the structure statically indeterminate. This erroneous conception was probably due to the fact that the stabilizing forces were imperfectly understood. But with the gradual march of progress, the theory and design of spiral holders have developed to such an extent that all doubt as to the reliability and safety of these structures has been dispelled. The confidence which the Gas Industry now has in this type of gas container is reflected in the number of spiral holders that have been erected—many of them of large capacity.

Convection plus Radiation

THE view has been expressed on several occasions during recent months that some element of convection might to advantage be added to the heating effect of the radiant gas fire, provided such addition does not impair the proved advantages of the radiant fire—advantages which have gained for gaseous heating a high reputation. The idea is not new, and every now and then it undergoes intensive discussion, the effect of which is sometimes to produce modification in the usual design of gas fire—such, for example, as an extended low-temperature radiating panel above the canopy.

At no time, however, has interest in convection heating been more pronounced than it is at present—due largely, we think, to the admirable researches on gaseous combustion which have been prosecuted so successfully during the past few years both by the Institution of Gas Engineers and by individual gas undertakings, notably, of course, by the Gas Light and Coke Company. We know a great deal more about combustion and its products than we did, and this knowledge is having its result in the marketing of warm air appliances—convection heaters—of various types and sizes, one of the most interesting being the unit heater, which has met with ready acceptance in the United States. There is, of course, no question of convection ousting radiation; the point is that—to use a familiar expression—there is room for both. Certainly the past twelve months has witnessed unusually rapid advance in the design of both radiant and convective gas heaters. The range of reliable heating appliances which the Gas Industry is now able to offer the public was never more varied or more satisfactory.

Abstracts of new inventions relating to gas fires designed to yield, in addition to radiant heat, a measure of convection are often to be found in our "Register of Patents;" and some of these may appear a little fantastic. In to-day's "JOURNAL," however, is a description of a radiation-*cum*-convection heater which, we are assured by a correspondent, has for the past three years proved satisfactory, from all points of view (particularly from the aspect of ventilation), in Germany. The construction of the fire can be seen from the diagrammatic sketch we reproduce, and its appearance from a photograph. The most startling feature of the appliance lies in the disposition of the radiants which are inclined forwards away from the base. It is stated that this does not impair the radiant efficiency, and we are told that the temperature of the radiants is higher than is normally the case with vertical radiants. This seems an interesting piece of apparatus, and we should be glad to have the views of readers regarding its possibilities.

Regeneration of Wash-Oil

A GOOD deal has been written during the past two years about naphthalene recovery and the question of the deposition of gums on the district, and the latest investigation on the subject—undertaken by Mr. Thorpe, of the Huddersfield Corporation Gas Department, for a description of which he was awarded the Diploma of the Institution of Gas Engineers—adds much to the information already gained, and, to our mind, shows in no uncertain way the value of recovering benzole from coal gas, particularly where it is desirable to "dilute" the "straight" gas before it is passed into the district mains. An extract of Mr. Thorpe's thesis is published in our columns to-day, and should arouse discussion throughout the country.

Having expressed the opinion that ordinary gas oil is the best absorbent for naphthalene, and demonstrated in graphic form the advantages which have accrued to his undertaking since naphthalene washing was practised, the author explains, as a result of his experimental work, that there is every reason to believe that naphthalene washing also removes some substance or substances which act as inhibitors to the formation of gums as a result of polymerization and oxidation of unsaturated hydrocarbons (especially those of high boiling-point). Hence, why not remove, in the one operation, both naphthalene and these gum-forming constituents? Very little modification in working is needed—it is only a matter of increasing considerably the rate of passage of the oil through the washer. Regeneration of the oil must be carried out at the same rate, to maintain at a maximum the power of the oil for removing the naphthalene and the unsaturated bodies.

All that happens in the new regenerating plant, which is due to Messrs. W. C. Holmes & Co., Ltd., is this: The oil is pumped through a preheater and afterwards through a distilling column, where it meets a current of live steam which carries away the naphthalene and other bodies, together with a certain amount of benzole. The oil which leaves the still is, after cooling, ready for immediate passage back to the washer. The vapour leaving the distilling column is fractionated into two portions—one containing the naphthalene and other heavy hydrocarbons, and the other crude benzole. Every day, the quantity of this benzole is between 80 and 100 gallons on a stream of gas varying between 3½ and 5 million c.ft. A glance at the balance-sheet showing the financial statement for the production of 100 gallons of benzole a day is illuminating—a pleasant profit of £1 10s., taking the

value of the gas at per therm into holder, which is, of course, the proper basis. This explains why the Huddersfield Gas Department does not return the benzole into the gas supplied to the town. Moreover, in this statement the saving in wash-oil is not placed to the credit side of the balance-sheet—a saving which in Mr. Thorpe's case is £125 per annum. Altogether, the contribution under review is suggestive; it will certainly result in a great deal of thought, and it will very likely result also in action, at any rate on the part of those undertakings which, having horizontal retorts as their carbonizing plant, are reducing the high calorific value of the gas made to the standard supplied according to the Gas Regulation Act. Benzole recovery is a scientific and technically sound method of effecting dilution; air is definitely a wrong diluent to use, while producer gas, though admittedly a different proposition from air, has the obvious disadvantage of introducing a large proportion of inert gas which costs money to distribute. As time goes on, and the distribution systems have still further demands imposed upon them, the question of "inerts" will naturally assume greater significance.

Mechanical Costing

One of the most fascinating developments of modern times is the mechanical book-keeper, which may now be regarded as an essential part of the equipment of a large gas undertaking, as, indeed, it is of any big business. Sentimentalists may experience gloom on seeing the working of a mechanized office, but that does not alter the fact that billing, calculating, and costing machinery has come to stay. It is three years since we published an illustrated article describing the mechanical system operated by the South Metropolitan Gas Company for dealing with monthly accounts to approximately 115,000 consumers through ordinary meter; in the "Journal" to-day will be found a paper on "Costing in Relation to the Manufacture of Gas," which Major R. N. Barnett, Chief Accountant to the Company, read at a meeting of the Eastern District of the Southern Association of Gas Engineers and Managers.

The great advantages of mechanical book-keeping are, of course, the speed and the accuracy with which statements of cost can be compiled, and the great flexibility of the system. From "master cards" there becomes available an enormous amount of information which can be tabulated in more detailed form whenever such sectionalized details are needed. The undertaking as a whole becomes a centralized costing unit, and from the central cost office the various stations or departments can be supplied within a few hours with statements of comparative costs. The central cost office becomes, in effect, a super-detector of waste, and if some of the records indicate unusual expenditure, it becomes an easy matter to arrive at the source of leakage. Major Barnett observes that the captain of a vessel does not sail from port to port with just a hope that the weather will be fine and the sea calm. Not only does he know his destination and date of arrival, but he takes his bearings day by day to ascertain if he is in advance of, or behind, his schedule. The same sort of procedure is necessary in the piloting of a modern business. The gas undertaking which carefully estimates and plans its expenses and revenue in advance, and compares the actual figures with the estimates week by week or month by month as the year progresses is the one which will be the most successful. If costs are kept completely under control, an immediate warning will be given of anything untoward, and steps can be taken to rectify matters.

The author explains the working of the South Metropolitan Company's system, and, to give some idea of the speed of compilation, mentions that if the wages of the men are paid on Friday morning some of the statements of a detailed nature can be in the hands of the engineers before the men have been completely paid; and each week end an engineer is able to ascertain how the wages have been expended, and to discover any irregularities that may have occurred during the wages week. A comprehensive comparative carbonizing return is compiled to show the cost per 100 therms and per ton of coal carbonized, and the average of all stations for the present and the past year. This enables everyone concerned to distinguish the rises and falls in carbonizing process cost and the works at which gas is being most economically produced. Then, to give another example of the utility of mechanical costing, it is an easy matter to ascertain any particular shop's overhead charges and compare prices with outside quotations, effect economies in the administration of the shops, and be in a position to substantiate the running of them as an economical proposition. These examples are selected from Major Barnett's paper to indicate the wealth of vital statistics which can be compiled mechanically at a moment's notice. And, as the author points out, centralization of costing makes possible the use of the most up-to-date office machinery which would not only be available for costing, but could be used for any other department of a company which had work to be done, but which work would not justify the cost of a complete installation of machinery or the employment of additional staff. Finally—and a very important consideration—all the figures supplied would have a direct relation to the figures which form the final accounts of the undertaking.

Kettering Gas Bill

Mention was made last week by our Parliamentary Correspondents of the fact that the Private Bill which is being promoted by the Kettering Gas Company, one of the clauses of which prohibits the Kettering Urban District Council from prescribing the particular form of lighting and heating to be used in their Council houses, was likely to meet with a considerable measure of opposition from the electricity interests, "which have usually reaped the benefit of such discrimination in the past." The reason for anticipating such opposition was that the Incorporated Municipal Electrical Association had been busying themselves in circularizing local authorities who produce their own electricity with the idea of getting them to ask their Members of Parliament to cast their weight against the Bill.

It is surprising that local authorities with electricity undertakings on their hands should use such means as are objected to at Kettering, and even more so that the Incorporated Municipal Electrical Association should ask their members to point out to Members of Parliament "that the question is one which primarily affects the various Councils in their relations as between themselves as landlords and their tenants." Surely it would be more correct to point out that the question is one which primarily affects the freedom of the subject. The policy of erecting Council houses has been dictated by a large unsatisfied demand for working-class dwellings, and some Councils who own their electricity supply undertakings have taken advantage of this demand to impose a condition which they would have been hardly likely to regard as businesslike had the case been one of landlords looking for tenants, rather than of tenants competing for houses.

A Council is right to lay down conditions of tenancy, but they should be conditions suggested by considerations of public health, &c., and not such as this one. The Gas Industry is out to secure fair play in this matter, both for the tenants and for itself. While the Councils owning electricity undertakings and the electricians are putting forth their utmost endeavours to bind tenants to the use of a form of energy which they may not desire to use, the Gas Industry must leave no stone unturned to secure for these same tenants just the same freedom in choice of the form of light, heat, or power they will employ as is admittedly theirs in the matter of any other commodity they may wish to purchase.

The circular of the Incorporated Municipal Electrical Association led to a lengthy debate in the Weymouth Town Council, and in the course of it one of the members (Mrs. Comben) said: "This matter affects the women more than the men. I believe in freedom, and a woman should be free to choose which she wants—electricity or gas. Let them use gas and electricity as well. That is what I do." A better summing-up of the case would be hard to provide; and it is the fight for this freedom by the Kettering Gas Company that is so alarm-

ing the Incorporated Municipal Electrical Association, as it "would create a precedent for future gas legislation."

That a Council house tenant should be compelled to sign away his freedom in a matter like this raises a question of principle of the first importance; but even apart from the vital consideration of principle, a tenant is paying an unreasonable price for the privilege of living in a Council house if he be thereby debarred from using so thoroughly satisfactory a form of energy as gas. Is it fair, for example, that tenants of Council houses should be forbidden to take advantage of what is by far the most popular means of cooking throughout the country, and be made to use that which is furnished by the municipally owned electricity undertakings? Compulsion of this character reveals municipal trading in its least attractive light. Gas and the Council house tenants demand in this matter but the barest justice. Why should the possibility of it being granted so alarm the electricians?

PERSONAL

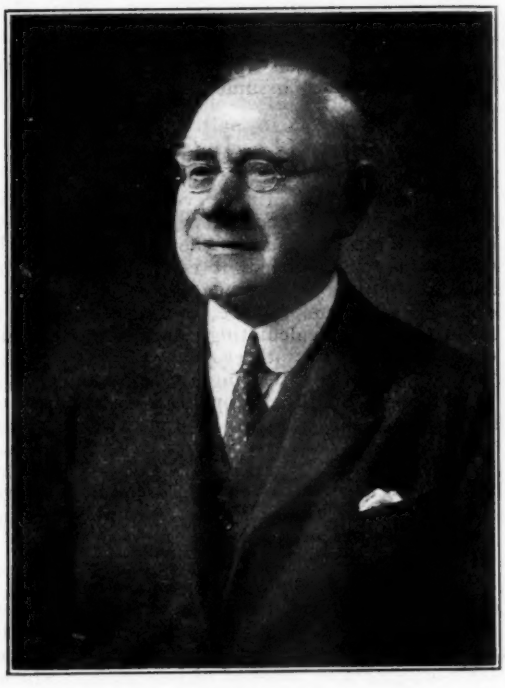
H. L. P. ALLENDER.

To commemorate the fiftieth anniversary of the day when Mr. Henry Lewis Phipps Allender first embarked on his business career with the firm of Messrs. Stevens & Co., then Proprietors of "Torbay" paint (of 26-28, Billiter Street, E.C. 3), an address was presented to him at a Board meeting of the Torbay Paint Company, Ltd., on Monday, Jan. 11. Mr. Allender, upon leaving New College School, Oxford, commenced as a junior clerk with the firm, and working his way through all Departments was appointed Manager at an early date. From 1890 he travelled extensively in the Midlands and the South, where he made many friends. He succeeded to his Partnership in 1912 under the will of the late Mr. Freeman Burrows, and was appointed Secretary and Director in 1925, when the firm of Stevens & Co. was converted into the Torbay Paint Company, Ltd. In 1928 Mr. Allender relinquished the position of Secretary in favour of his son, retaining his interest in the Company by accepting the position of Consulting Director; and to-day he is actively engaged in supervising the Colonial and Overseas Section of the business.

It is proposed to confer the honorary freedom of the City of Birmingham upon Alderman JOHN HENRY LLOYD, for many years Chairman of the Corporation Gas Committee of that city, and the "father" of the City Council. He has been a member for over 40 years.

Mr. R. W. EDWARDS, J.P., C.C., Chairman and Managing Director of the Mid-Southern District Utility Company, has sufficiently recovered from his recent severe illness to be able to resume his official duties as Mayor of Aldershot.

On Friday, Jan. 15, at a dinner at the Engineers' Club, Manchester, attended by the Directors and principal officials of West's Gas Improvement Company, Ltd., a presentation was made to Mr. R. J. H. SAYERS, M.I.Mech.E., M.Inst.Gas E., on his retirement from active association with the Company. Mr. Sayers was Chief Engineer to the Company from 1884 to 1919, when he was appointed London Manager, the position he has since held. Mr. Sayers still enjoys excellent health and it is hoped that he will keep in touch with the Gas Industry for many years to come.



Mr. R. J. H. SAYERS, M.I.Mech.E., M.Inst.Gas E.,
A presentation to whom is recorded on this page.

On the same occasion a presentation was made to Mr. HENRY ALLCHIN, who has been for many years the senior Inspecting Engineer to West's Gas Improvement Company, on his retirement from active service.

OBITUARY

MR. FRED LEE.

Gas Engineer, Manager, and Secretary at Hinckley for over thirty years, Mr. Fred Lee, one of the best-known and most respected public officials in South Leicestershire, died in Hinckley and District Hospital on Saturday night, aged sixty-one. He went into the institution the previous Sunday for an operation, but there were unexpected developments, making a second operation necessary on Friday. This was not successful, and Mr. Lee rapidly sank and passed away the following day. His death came as a great shock in the circles in which he was so deservedly popular.

Mr. Lee went to Hinckley in 1897, and took charge of the local gas-works, which were owned by the Urban District Council, at a time when they were not a particularly paying proposition. He set about a re-construction of the entire undertaking, and largely as a result of his acumen and perseverance he gradually converted the works into a concern which eventually became the most profitable with which the public authority has ever been associated. Obsolete plant and apparatus disappeared, and the old retorts were replaced by more up-to-date methods of gas making, leading not only to a better and cheaper gas, but to greater all-round efficiency and economy. To-day Hinckley is in a position to supply factories at 2s. 6d. per 1000 c.ft., and for lighting at 3s. 2d. per 1000 c.ft.

Some idea of how the works at Hinckley have developed in the last fifty years is evidenced by the fact that, whereas in 1882 the total consumption was 16 million c.ft., it was last year 216 millions. Mr. Lee lived to see Hinckley not only supplying gas to Burbage, but in recent times negotiate successfully with the rapidly-developing industrial parishes of Barwell and Earl Shilton for supplies direct from the Hinckley Works, the old gas undertaking at Earl Shilton being scrapped.

Deceased, who came from Marston, in Yorkshire, leaves a widow and a son, Mr. Harold Lee, now a student at Guy's Hospital. His life's work was the Gas Undertaking at Hinckley, but he was also a member of the Knights of Malta Lodge of Freemasons, and for some years was associated with Hinckley Rotary.

Mr. BENJAMIN FRANK, who died at Helmsley on Jan. 20, at the age of 76, was Chairman of Directors of the Helmsley Gas Lighting Company, and a local magistrate.

CORRESPONDENCE

Technical Development of Gas Fires

SIR,—The article of Mr. J. H. Brearley published in the "GAS JOURNAL" of Dec. 2, 1931, reopens the discussion whether additional heating surface providing convected heat should be added to a gas fire of the radiating type. Mr. Brearley asks that the Industry should find the answer whether the air can be warmed to a moderate degree supplementary to the radiant energy without in any way impairing the reputation of the appliance.

German manufacturers have tried for the last ten years to increase the efficiency of a radiating gas fire by means of additional heating surface. The first constructions were not satisfactory, and some years ago it seemed to be impossible completely to remove the flue gases from the room when a surface heater was added to the radiating fire. Further experiments, however, have shown that one went too far in trying to look for higher efficiency.

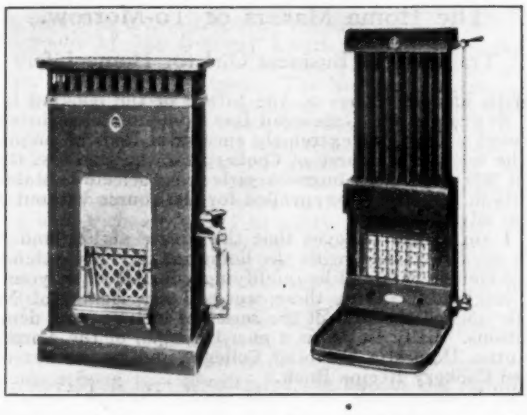


Fig. 3.

Showing the appearance of the new type fire.

Fig. 1.

Old-style, unsatisfactory gas fire with convective heating surface.

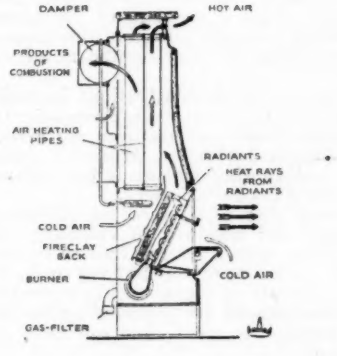


Fig. 2. -New Style Radiating Gas Fire with Convective Heating Surface.

Furthermore it was demonstrated that by conducting the flue gases through several pipes to the chimney (fig. 1) the problem was aggravated on account of the greater friction of the gases and the loss of draught in the numerous bends and corners. The upper part of a fire built according to this principle should be more like a hood, giving as little resistance as possible to the free passage of the gases. Proper efficiency may be obtained by putting some vertical pipes into this hood for conducting and warming the air (fig. 2).

The most surprising factor for the British engineer will probably be the radiants leaning forward top foremost, and the firebrick behind these radiants inclined in the same way. It may be feared that the radiant energy will be marred in spite of the reflector of polished nickel plating underneath the radiants. Several tests, however, showed that the radiant efficiency was not less than usual. The effect of the firebrick thus placed was quite helpful in improving the ventilation. The gases when rising by the heat after combustion flow over the surface of the firebrick, and the tendency to expand due to diffusion and troublesome air currents from outside is thereby overcome by the confined space which is allowed for the gases. By this means the percentage of flue gas concentration was increased from 3·8 p.ct. CO_2 with vertical radiants to 6·1 p.ct. CO_2 with radiants leaning forward (both figures being obtained with German standard gas of 473 B.Th.U. per c.ft.). The temperature of the radiants was also considerably higher and likewise the temperature of the gases on leaving the radiants and entering the hood.

The better the concentration, the higher the temperature of the gases can be on entering the chimney (vertical radiants: 356° Fahr., inclined radiants: 446° Fahr.) without lessening the efficiency of the heater.

Gas fires of the improved style have been in practical use for three years. They have proved to be absolutely reliable in removing the flue gases from the room, the dilution being so strong that each unit of gas consumed carries away 9 to 10 units of ventilating air.

The radiant energy, which was examined several times by very accurate tests, was, compared with the unit of gas consumed, always found to be not less than that of ordinary radiant fires, the intensity of radiation being even higher owing to the temperature of the radiants.

As to "impairing app arance" this is a matter of taste and cannot be argued. In Germany the simple models of sheet iron in grey aluminium bronze are considered to be quite nice looking (fig. 3), but it should always be possible, once the principle is clear and the construction has been perfected, to adapt the appearance to the special taste of a country.

J. KÖRTING.

Askania-Werke A.-G.,
Dessau,
Jan. 16, 1932.

Perforated Central Offtakes for Coke Ovens

SIR,—Dr. Foxwell's article in the issue of the "JOURNAL" for Jan. 15 is exceedingly interesting, but it needs amplification in some respects. His objection to the use of perforated central offtake pipes is, in general, quite sound. The writer has witnessed experiments with Parkgate coal in a low-temperature retort provided with such perforated tubes, and it was invariably found that there was a tendency for "teats" of plastic matter or coke to fill up the orifices. It was proved that this could be minimized by blending, and using a charge which did not produce excess plastic matter.

That advantages and disadvantages arise from the use of central offtakes has been proved in another low-temperature retort, where it was found that, if the offtakes were not placed at sufficiently short intervals apart, the process of coking was definitely retarded, but when properly spaced they aided coking. It is, of course, obvious that if the moisture of the coal takes an inward, rather than an outward, path, the useless expenditure of heat in superheating the water vapour is avoided, but what is not quite so obvious is that the advantage can also prove to be a retrograde step, if not properly applied. This fact has also been demonstrated on a plant where the principle actually caused considerable retardation of the process. The writer, however, has devised means of making use of the principle of central offtakes, while obviating the disadvantages mentioned. It is not at present opportune to deal with this modification.

Regarding the quality of the tar, it is clear that if the low-temperature volatiles are mixed with the high-temperature products, a mixed tar will result, but will this not be very similar to the tar at present obtained in continuous vertical retort practice, where high and low temperature volatiles are collected in one stream?

JOHN ROBERTS.

5, *Victoria Street,*
Westminster, S.W. 1,
Jan. 21, 1932.

THE NEWS OF THE WEEK

South Metropolitan Gas Company.—Subject to audit, the Directors of the Company recommend a final dividend for the past year on the Ordinary Stock at the rate of 6 p.ct. per annum, less the interim dividend of 2½ p.ct. paid in September last.

Commercial Gas Company.—The Directors of the Commercial Gas Company will recommend at the annual general meeting to be held on Feb. 11 the payment of a dividend for the half-year ended December, 1931, on the ordinary stock of the Company at the rate of 5¾ p.ct. per annum less income-tax.

Barnoldswick Gas Department held an exhibition of domestic gas appliances last week at the Albert Hall, and the same undertaking has now removed the exhibition to Salterforth. The exhibitions have been arranged by Mr. J. P. Thomson, the Council's Gas Engineer, in conjunction with well-known makers of lighting, cooking, heating, and other appliances.

The Extension of a Main to Clifton, a village three miles south of Penrith, has been completed by the Penrith Urban Council. A good number of houses in the village have already been piped, and the response from customers has been very gratifying. The scheme has been carried out under the direction of Mr. J. Corrigan, Gas Engineer and Manager to the Council.

An Unusual Case was heard by the Neath Magistrates last week when Vernon Mainwaring, of Neath, was charged with improperly using gas by lighting a street lamp. The Chief Constable said that a street lamp which should have been automatically extinguished in the early morning remained alight during the day, and it was discovered that defendant was in the habit of climbing up the lamp post and tampering with the mechanism. Defendant was a lorry driver and the lorry was garaged near the lamp-post. In the early morning he had no light to work on the car, so provided some by lighting the gas lamp. The lamp was lit for several days, said the Gas Manager, and there was a considerable wastage of gas. Defendant pleaded guilty and was bound over for six months.

In Connection with the B.I.F., by the invitation of the Rector of Birmingham (Canon T. Guy Rogers, M.C., B.D.), a Special Service will be held at the Parish Church, Birmingham (St. Martins, Bull Ring), on Sunday, Feb. 28, at 10.45 a.m., when the Preacher will be the Most Rev. the Lord Archbishop of York. The Service will be attended by the Lord Mayor of Birmingham, the President and Members of the Birmingham Chamber of Commerce, and Exhibitors and Buyers at the British Industries Fair, Birmingham. It is anticipated, in view of the visit of the Lord Archbishop of York, that the seating capacity of the Church will be taxed to the utmost, and in order that an adequate number of seats may be reserved for members of the Chamber, and Exhibitors and Buyers at the Fair, the Secretary of the Birmingham Chamber of Commerce, 95, New Street, has been requested to obtain an approximate number of seats the Chamber will require. He therefore desires to know the number of tickets required by individuals or firms.

Salerni Process.

Sir Eric Hambro, who announced last month that he was providing the initial funds to develop the Salerni low-temperature carbonization system in this country, has had to postpone his proposed tour of the coal mining centres owing to a severe attack of influenza.

In an interview last week he said: "I have been extremely gratified with the tremendous interest that has been taken all over the country in the plans for the development of the system, although owing to my illness I have been unable to take an active part. I am firmly convinced that the rational treatment of coal so widely affects the interests of this country that the fullest possible technical information as to the working of the Salerni system should be made public at once.

"Although until such time as the first industrial unit has been put up and has proved the claims by actual demonstration, the matter is a purely personal one between Commendatore Salerni and myself, it has been decided to issue forthwith a paper by Commendatore Salerni giving a full description of the process and apparatus with diagrams and drawings in order that fuel technologists and engineers may be in a position to form an exact opinion of the value of the invention and be able to raise publicly any questions that they may wish, and to offer criticisms, if any."

The Home Makers of To-Morrow.

Training the Business Girl for Home Life.

With an eye always to the future of the cooking load, the Newcastle and Gateshead Gas Company have brought forward a new and extremely successful item of publicity in the form of a Course of Cookery for the Business Girls. Over 300 good class business girls from selected establishments in the city were enrolled for the course without any Press advertising.

"I am a firm believer that the future of England lies, in a great measure, with the home maker. By attending these courses you will be qualifying yourself to do your bit for England." With these words Lady Bolam of Newcastle opened the first of the series of lectures and demonstrations. Lady Bolam is a past-Principal of the Northern Counties Domestic Training College, and an author of a noted Cookery Recipe Book.

The business girls are taken gently through the art of cookery, commencing with the choice of the right kind of foodstuffs, good marketing, the main principles of cookery, then on to bread-baking, a four-course dinner, cakes, pastries, &c.

Good publicity in the form of photographs and articles in the news columns of all the local newspapers was obtained before and after the commencement of the course. Sir George Hunter (the famous shipbuilder), when he heard of the course, sent a message of encouragement. The marked interest and enthusiasm of the business girls at the opening demonstration was significant of success of such a venture.

In addition to the demonstrations in cookery held each week throughout the year in the Newcastle Gas Company's area, demonstrations and lectures are given to Women's Guilds, Women's Institutes, Women's Political Associations, &c., and another feature is the training of the Girl Guides for their Cookery Badges.

Letters were sent to selected establishments requesting their support and goodwill in enrolling names of their female staff for such a course (notice cards giving particulars of the course were sent to hang up in the staff room). The course consists of eight weekly evening lectures, and note books and pencils are provided by the Newcastle Company. Homework is given, and questions and difficulties are answered.

The hall chosen is an ideal one for such a course, being in the centre of the city and having raised seating accommodation curving around a central platform.

Institution of Gas Engineers.

Members of the Institution desirous of attending the 9th Annual Distribution Conference of the American Gas Association in Birmingham, Alabama, from April 6 to 8, 1932, are invited to communicate with the Secretary of the Institution, at 28, Grosvenor Gardens, London, S.W. 1.

The Chairman of the Distribution Committee of the Technical Section of the American Gas Association, Mr. F. A. Lydecker, of the Public Service Electric and Gas Company, Newark, New Jersey, will preside at the Conference.

The programme will deal with, *inter alia*, the latest developments in pipe joint research, gas unaccounted-for studies, new and up-to-date developments in the change-

over from manufactured to natural gas, together with a symposium on the servicing of automatic equipment.

Members of the Institution are invited to attend the meeting of the London Section of the Society of Chemical Industry in the Chemical Society's Rooms, Burlington House, W. 1, at 8 p.m., on Monday, Feb. 1, 1932, when Mr. H. A. F. Lindsay, C.I.E., Indian Trade Commissioner, will read a paper on "Modern Trade Tendencies and Where They are Leading."

Tickets of admission are not required, but members are required to sign the Visitors' Book.

"Bold Action and Increased Efficiency."

Writing in the "Empire Mail" for January, Sir Francis Goodenough, C.B.E., Chairman of the British Commercial Gas Association, and President of the Incorporated Sales Managers' Association, states: "The New Year opens with grave problems facing the British Empire in common with the rest of the civilized world, and they present greater difficulty to our statesmen than to any others because our position as the centre of international exchange and finance imposes upon us an immense responsibility. Failure on our part to act wisely and with long sight, and a full appreciation of probable world reactions to our policy, would be a catastrophe of the first magnitude.

The result of the General Election in October, however, gives us the right to view this grave situation with courage, hope, and confidence. The National Government has a free hand and the assurance of an overwhelming backing for bold action, following thorough (which does not imply slow or prolonged) consideration of the facts.

The Prime Minister showed great courage and both insight and foresight in 1931. Mr. Baldwin displayed patriotism of the highest order in backing him without reserve and without regard to party considerations, and his lead was well followed by the Liberals. This gives us ground for faith that the National Government, abandoning entirely and for ever our traditional trust in our capacity for 'muddling through,' will think through, see through, and act through to a successful issue from the present confusion and chaos.

"But it is of the utmost importance that the industry and commerce of this country, as the hub of the Empire, should not leave it to the statesmen—hampered as they always are by the politicians—to do the whole job of rehabilitation. It is far beyond their capacity and power, be their intentions never so good, and their wisdom and activity never so great.

"The commerce and industry of this country can be restored to their former strength and can progress further only if the manufacturers and traders of the country realize their personal responsibility, and strain every nerve to raise the efficiency of production and marketing to the highest possible point by the adoption of scientific in place of haphazard, happy-go-lucky policy and methods, alike in board-room, factory, and sales organization.

"The times demand ruthless self-criticism and unfaltering reform where self-criticism and adversity have proved it to be necessary. We must not leave it to the State to save us from our state. We must save ourselves by action, and prove ourselves worthy of the Empire which our forefathers built up by initiative, courage, and work. I believe we shall; I am sure we shall. But we shall not do it by faith or confidence, but by action."

Co-Partnership Supper at Eastbourne.

Some 280 employees of the Eastbourne Gas Company spent an enjoyable time at the Town Hall on Jan. 21, as guests of the Chairman and Directors at the annual supper, which is connected with the co-partnership scheme.

After an excellent meal, the company listened with interest to a short speech by the Chairman. Messrs. Bobby's orchestra played popular music during supper and afterwards.

Mr. Frank H. Jones, the Chairman of the Company, presided over the gathering. He said that that annual event arose from the co-partnership scheme, which with the pensions fund and other benefits he had helped to start, as elsewhere. They had to remember the three sections—employees, consumers, and owners, among which latter, he was glad to know, could now be numbered most of those present. It was just as important that each one of them should do his or her best for the benefit of all, as for the Directors, or anybody else. He had worked with three different Secretaries and Works Managers of the Company.

There was sentiment in the thought that during the 60 or 70 years the works had been on the marshes the manufacture of gas, and the work connected with it, had never stopped for a single moment. Nearly all the Company's employees were present, but they must remember the 15 or 25 men who were engaged at that moment in the making of Eastbourne's gas and could not be with them. Sundays, Christmas Days, holidays, when they were all fast asleep—there was part of the "show" running all the time.

Later in the evening Mr. A. Lee, who has been in the Company's employ for 31 years, moved a vote of thanks to the Directors, and it was cordially given. He spoke of Mr. Jones as "the father of the Company," which, he said, had always had good leaders. The co-partnership scheme had been a great success, and he could see no reason why it should not always be so.

Institution of Chemical Engineers.

Tenth Annual Corporate Meeting.

The programme for the Tenth Annual Corporate Meeting of the Institution of Chemical Engineers has just been issued. While this function is confined to one day only, there should be no lack of interest in the proceedings.

The meeting, which is being held at the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, Feb. 19, opens with the usual session for members only, at which the formal business of the annual meeting of the Institution will be transacted. The meeting will be opened to the public at 12 noon, when the President, Mr. W. A. S. Calder, will give his Address, the subject being "Control of Industry." In view of Mr. Calder's long and intimate connection with the Chemical Industry, an interesting and authoritative address may be anticipated.

After the adjournment for lunch, Dr. Ezer Griffiths, F.R.S., of the National Physical Laboratory, will present, at 2.15 p.m., a paper on "Thermal Insulation," in which he will deal with types of apparatus for thermal conductivity measurements, investigations into heat loss from a pipe surface in air, characteristics of some heat insulation materials and methods of estimating heat flow in complex structures. Dr. Griffiths is, of course, well known as an authority on heat problems.

In the evening, in the Grand Hall of the Hotel, the Annual Dinner will be held, under the Presidency of Mr. Calder. The principal speaker will be Sir Harry McGowan, K.B.E., Chairman of Imperial Chemical Industries, Ltd., and we learn that other speakers will include the Rt. Hon. Lord Leverhulme (President-Elect) and Sir John Cadman, K.C.M.G.

The Toronto Gas System.

Writing in the Toronto "Globe," Mr. Arthur Hewitt, Vice-President and General Manager of the Consumers' Gas Company of Toronto, explains that throughout 1931 the inherent soundness and the stability of the Gas Industry in Canada were simply demonstrated in the record of the business of the Consumers' Gas Company of Toronto.

While it is true that the retarded activity of industry and business in general has had the effect of lessening, temporarily, at least, the demand for gas for industrial heating operations, nevertheless the total volume of gas sales was well maintained, and it was possible for the Directors to make a reduction in the price of gas, representing a saving to the gas consumers of Toronto of an amount of approximately $300,000 per year.

The capital stock of the Company outstanding on Sept. 30 last was $13,250,000, of par value $100 per share. This capital is owned by 3045 shareholders, the average holdings per shareholder being 43 shares. Naturally, so essential and so stable an industry as the gas business offers particularly attractive possibilities for the conservative investor. The satisfactory market record of the Company's shares, together with an uninterrupted dividend record of eighty-three years, makes the shares of the Consumers' Gas Company a favoured investment, especially with people of moderate means. The high regard in which the shares of the Company are held by investors generally is indicated in the fact that during a period in which the market prices of most industrial stocks were receding, the price of the Company's shares was fully maintained. The simplicity of the financial structure of the Consumers' Gas Company has been a contributing factor to this record, the capital being all common stock, with no preferred stock, bonds, or other senior securities ranking ahead of it.

A gratifying feature of the stock ownership is that it is almost wholly Canadian in character, more than 94 p.ct. of the Company's shares being owned in Canada. Over 75 p.ct. of the total is owned by people resident in the territory served by the Company.

The maximum dividend rate permitted by the Company's

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Act of Incorporation is 10 p.ct. on the par value of the capital stock. Owing to the high premium received from the sale of the Company's capital shares, and to the investment of the premium, as well as the capital, in plant and equipment, the Company need earn only slightly more than 5 p.ct. on its total assets in order to pay 10 p.ct. dividend on the par value of its capital stock outstanding.

Engineers' German Circle.

In view of the great importance of the German language and of the high standard of technical work in German-speaking countries, it has been decided to form an Engineers' German Circle with the following objects in view: (*a*) To further the study of technical German; (*b*) to give an opportunity of hearing lectures in German by eminent German-speaking technical men; (*c*) to bring together engineers interested in Continental technical developments. A programme of six or so meetings is in preparation. Each meeting, which will be held at the Institution of Mechanical Engineers, will consist of a short lecture and discussion in German, followed by an opportunity for further German conversation.

The Circle has the support of the Council of the Institution of Mechanical Engineers and of the Verein Deutscher Ingenieure. The annual subscription to the Circle is five shillings, and members of the Institution of Gas Engineers may obtain Application Forms for membership from the Secretary of the Institution, Mr. J. R. W. Alexander, M.A., LL.B., 28, Grosvenor Gardens, London, S.W. 1, or from the Secretary of the Circle, Mr. H. P. Spratt, B.Sc., the Library, Science Museum, London, S.W. 7.

The inaugural meeting, to which members of the Institution of Gas Engineers are cordially invited, will be held at the Institution of Mechanical Engineers in the Reading Room, on Monday, Feb. 1, 1932, at 6 p.m., preceded by tea at 5.15 p.m.

Introductory addresses will be delivered on behalf of the Institution of Mechanical Engineers and of the Verein Deutscher Ingenieure and by His Excellency Herr Dr. E. H. Rueter or another representative from the German Embassy; after which, Herr Ingenieur Ernst Schneider, of the Maybach Motorenbau, Friedrichshafen, will lecture on "Allgemeine Anwendung von schnelllaufenden Verbrennungsmotoren für Land, Wasser, und Luft" (General application of high-speed internal-combustion engines for land, water, and air). The lecture will be illustrated with lantern slides.

A New Departure in Oldham.

Manufacture of Gas Mains.

A development of industry in the Oldham district, which is likely to have far-reaching consequences in enhancing the prosperity of the town, is of especial interest to all those engaged in the Gas Industry, either as local authorities or as private undertakers. Messrs. Platt Bros. & Co., Ltd., have obtained, and are now fulfilling, an important contract for the Oldham Corporation Gas Department for the supply of 24-in. pipes in connection with a gas main the approximate length of which is four miles.

Messrs. Platt Bros. are a firm of textile machinery manufacturers of world-wide reputation, although, in addition to their huge works specially adapted for textile purposes, they have always maintained a large general engineering production department for the maintenance of certain colliery, quarry, and brickmaking machinery. In this direction they have always been pipe producers. Furthermore, many of the parts manufactured in textile machinery production, such as cylinders and rollers, are in themselves pipes, and it is possible that the firm were among the pioneers of end-on casting, which is a requisite of present-day pipe production.

The firm are able to produce cast iron at a rate of well over 1000 tons per week. This output can be handled by their own transport department. They are extensive users of gas for all sorts of purposes, the Oldham Gas Undertaking supplying them with 40 million c.ft. per annum, and more than double that quantity previous to the present industrial slump. Gas is extensively used by them for the heat treatment of spinning rings, for hardening cutters, lathe tools, &c. It is also used for heating a "salt" bath for hardening ring spindle blades, and there are also in operation a number of carburizing furnaces at the East Hartford Works of the Company which are gas-fired.

The heat treatment of spindle steels is especially interesting. It is done by heating the spindles in a "salt" bath in a furnace which is gas-fired. The temperature of the "salt" bath is maintained at a uniform rate throughout the operation—namely, 800° C. The spindles are immersed in the bath, and no matter what the duration of the immersion the temperature remains constant. The apparatus is the latest form of gas-heated furnace for this particular textile purpose and for the heat treatment of steels generally. The firm state that one of the great advantages of using gas for this purpose is that a "mellow" heat is obtained which cannot possibly be produced by the use of coal or by pulverized fuel. The salt bath prevents oxidation, and the tempering of the steel is of such a nature that, although a load of 110 lbs. at the centre of the spindle causes, roughly, a deflection of 2 in. yet, when released, the spindle takes no permanent set.

The contract for the Oldham Corporation being now well in hand, the firm invited the representatives of the Gas Undertaking to visit the works and inspect the method of manufacturing the pipes. The party were welcomed at the works by Mr. H. Wilkinson, Managing Director of the East Hartford Works, and also by Alderman F. Tweedale, J.P., one of the outside representatives of the firm.

The visitors were subsequently entertained at luncheon, at which Mr. Arthur Brothers, Deputy Chairman of Platt Bros., Ltd., presided.

Mr. Arthur Brothers proposed the toast, "The Success of Oldham," to which Alderman J. P. Hague (Mayor of Oldham) responded.

Alderman F. Pollard (Chairman of the Oldham Gas Committee) proposed the toast of Platt Bros., Ltd., and said that, as the result of placing the contract with the firm, the Oldham Corporation could now confidently recommend them to other local authorities requiring similar work.

Mr. W. R. Hall (Director) responded.

Councillor A. Colin Hanson, speaking as a member of the Oldham Gas Committee, expressed the hope that the name of Platt Bros. would be seen throughout the country where gas and water mains were laid.

Notes from Scotland.

Kirkcaldy Town Council are proceeding with the erection of a gas showroom.

Glasgow Corporation Gas Department have arranged with the local Miners' Union, or local pit owners, that Robroyston miners have so much per week deducted from their wages for gas; any surplus is to be refunded and any deficiency made good.

Growing Sales at Romford.

The Romford Gas Company has a statutory area of supply of some 25 miles, embracing the rapidly developing urban districts of Romford and Hornchurch and certain adjacent parishes. The number of consumers connected and appliances disposed of has greatly increased in recent years, necessitating substantial capital expenditure on new buildings, manufacturing plant, mains, meters, and stoves.

The foregoing is from an article in the "Financial Times," which mentions that on account of 1931 a half-year's dividend of 3½ p.ct. was paid on Sept. 1. The authorized stock capital is £350,000, including premiums. Under the Company's new Act, operative from Jan. 1, 1930, the old original and "B" shares were exchanged into 5 per cent. basic ordinary stock, and the preference shares into the same denomination of preference stock. During 1930 £50,000 ordinary and £19,000 debenture stock was issued.

Prince George at the Carron Works.

Included in the Scottish Industrial tour of H.R.H. Prince George was a visit to the Carron Works on Monday, Jan. 18. His Royal Highness, who was met on his arrival by Mr. F. L. Burder, Chairman of Carron Company, and the Directors and Manager, had only time to make a brief inspection of the works, but what he did see keenly interested him.

As he entered the works, two historic tablets built into the stonework were pointed out to the Prince. One with the date 1760 was part of the first blast furnace, while the other formed part of the cylinder made at the works in 1766 for James Watt's first steam engine. Two "Carronades" and cannon which had been in use during the 18th and 19th centuries interested the Prince as he commenced his tour.

The first place visited was the blast furnaces, where a "cast" was in progress. About 26 tons of molten metal were seen run into moulds or pigs, to form bars of pig iron, each of which weighs 1 cwt. After viewing this operation, the party ascended to the top of the furnaces, where they saw the raw material entering for the next "cast." It might here be remarked that the particular blast furnace

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seen by the Prince was the only one in use in Scotland for several months last year.

Thereafter the Prince was shown all the operations in the making of a bath. These commenced with the moulding and casting, and so keenly interested was His Royal Highness in this that he was oblivious to the sparks falling round him from the molten metal, which is heated to approximately 1500° C. Dressing and sand blasting were next inspected. Here the surface of the bath was made smooth and all dirt and sand adhering to the casting removed. The various processes in the porcelain enamelling were then demonstrated, the Prince finally seeing baths finished ready for despatch, several of which were in coloured enamels.

During the course of his tour at this point, there was presented to His Royal Highness the oldest employee of the Company, Mr. Peter Rae, J.P., warehouse foreman, who has 67 years' service. The Prince engaged in a conversation with Mr. Rae, who asked the Royal Visitor to accept a copy of his photograph.

Lunch was served in the Board Room at the works, when there was present in addition to Prince George and his equerry, Major Butler, Mr. F. L. Burder, Chairman of the Company, Mr. C. M. Brown, W.S., Secretary and Voting Partner, Dr. H. H. Brown and Mr. H. E. White, Voting Partners, and Mr. Geo. Pate, O.B.E., J.P., Manager, together with Mr. W. L. Pullar, Lord Lieutenant of the County of Stirling, Mr. A. G. Logan, Provost of Falkirk, and Major A. Balfour Gray, Town Clerk of Falkirk. Here Mr. Burder asked His Royal Highness' gracious acceptance of a coal vase and two models of a "Carronade" in "Carronium" metal.

Rochdale Gas Charges.

"With some revival in trade there is no doubt that the consumption of gas will increase." This remark was passed by Councillor Holt at the January meeting of the Rochdale Town Council when he referred to the proposal to increase the price of gas by 1d. per therm to all consumers of less than 250 therms per quarter. He regretted the necessity for an increase, but pointed out that the market for residuals had been falling for some years and the large quantity of ammonia which the Department made was valueless at present. There would be a drop of 3s. per ton on the year's sale of coke, which amounted to 29,000 tons, and income-tax was up by £2500.

During the first six months of the year there had been a drop of 7 million c.ft. in meter consumption. All these adverse factors were largely due to trade depression and to the closing down of several large works which used gas.

REVIEWS

WATER POLLUTION.*

The part which scientific research is taking in meeting the ever-increasing demand for plentiful supplies of pure water is revealed in the Report of the Water Pollution Research Board issued by the Department of Scientific and Industrial Research.

"The available sources, both surface and underground, of unpolluted water," says the Report, "are gradually being depleted, and there is no doubt that many rivers which are at present to some extent polluted, will have to be utilized in the future as sources of supply, after treatment, for both domestic and industrial purposes."

Under certain conditions rivers purify themselves. The extent to which it is necessary to purify sewage and trade effluents before they can be safely admitted to a river depends not only on the amount of the river water available for diluting them, but also on the action of the water on the various effluents. These questions are being carefully studied by the Board through a scientific survey of the pollution of the River Tees.

In a zone from Middlesbrough to Stockton, plant and animal life on the river bed are practically absent. This zone is subject to the greatest effects of pollution by sewage and effluents which contain specific poisons and which lower the concentration of dissolved oxygen in the river. This, however, is also the zone in which the greatest changes in salinity occur, and the complementary experiments in the corresponding zone in the Tay estuary, which is comparatively unpolluted, have shown that the scarcity of life in the central part of the Tees estuary cannot be attributed solely to pollution.

Some 2500 smolts of trout and salmon found dead or dying in the upper part of the Tees estuary have been collected. From an examination of these it appeared that their death could not be attributed to oxygen shortage alone. Chemical analysis of the effluents showed the presence of phenol and other tar acids, hydrocarbons such as naphthalene, and in some cases of cyanides, the latter in concentrations which were found to be lethal to smolts under experimental conditions.

"The distribution of the various toxic substances in the estuary of the Tees depends not only on the rate at which they are discharged and carried out towards the sea, but also on the rate at which they are broken down by bacterial or chemical action in the water. The course of this decomposition is being studied by chemical methods, and experiments are being made on the rate of decrease of toxicity towards trout of various effluents and constituents when diluted with estuary water and stored."

Considering the disposal of polluting effluents from any particular industry, the Board point out that "the first logical step is to ascertain whether it is practicable so to modify manufacturing processes that no polluting effluents need be discharged. In some cases it may be possible by simple treatment to render the wastes fit for re-use in the factory operations, and the polluting character of the effluents may be reduced by the recovery of products of value."

* Department of Scientific and Industrial Research. Summary of the Report of the Water Pollution Research Board for the year ended June 30, 1931. H.M. Stationery Office; price, 9d. net.

THE "YARD" SEAM OF THE NORTHUMBERLAND AND DURHAM COALFIELD.*

It is a pleasure to note that the Physical and Chemical Survey of the National Coal Resources is going on apace. In the recently published Report of the Fuel Research Board for the year ended March 31, 1931, it was announced that nine local laboratories have now been established in the principal coal fields, and when, as will shortly be the case, the last of these is fully staffed and equipped, some 96 p.ct. of our coal producing areas will be covered by the survey organization.

The latest publication (Survey Paper No. 21) is the first of a series dealing with the very important Northumberland and Durham Coal Measures, a triangular coal field of nearly 800 square miles including some of our best coking and gas coals. The report is on the Yard seam of the Northumberland area and gives the results of a comprehensive and detailed examination from roof to floor, of fourteen complete pillar sections of the seam taken at different points well distributed over the area.

The seam is well defined over a large part of the area and consists roughly of 3 to 5 ft. of workable coal. The coal is consistently fairly hard and moderately bright, has a strongly banded appearance due to numerous thin durain bands, and is often associated with a shaly band as well as with two thin bands of dirty coal, one at the top and the other at the bottom of the seam, termed locally "top brat" and "bottom brat" respectively. Care has to be taken to eliminate these dirt bands during mining in order to avoid high ash and sulphur content in the saleable product. On mining, the seam yields a fairly high proportion of lump coal which withstands transport well.

The analysis of the sections shows the coal to possess a fairly high uniform moisture content, about 8 p.ct. only becoming less (down to 3·4 p.ct.) towards the south as the Durham field is approached. Dirt bands and shale having been excluded from the samples taken, the ash content of the coal is found to be low, varying from 2 to 7 p.ct., and in only three instances reaching a higher figure than 4 p.ct. It is in coking properties, however, that the seam shows the greatest and a considerable variation, yielding very poorly coking coals in the north to highly swelling coals in the south.

The seam finds its chief outlet as a domestic fuel, the coal giving an intensely hot fire with a long flame. To a limited extent it is also used for industrial purposes, steam-raising, &c., and as bunker coal, but it is only in the most southern sections, as the valuable Durham field is approached, that fairly good gas coals are produced from the seam.

"TAMBT."

* Department of Scientific and Industrial Research. Fuel Research—Physical and Chemical Survey of the National Coal Resources No. 21. "The Northumberland and Durham Coal Field. Northumberland Area: The Yard Seam." H.M. Stationery Office, London, 1931; pp. VI. + 54, 1 map and 1 plate; price, 1s. 6d. net.

NOTES ON PLANT AND PROCESSES

"Witton" A.C. Frame-Cooled Motors.

The difficulty of making totally enclosed motors of medium to large outputs in frames of reasonable dimensions is fairly well known; it arises from the fact that all the losses in the machine have to be dissipated by radiation from the shell, and the frame size for a given output is thus settled by the external cooling surface necessary to dissipate the loss at that output.

It was to meet the demand for a totally enclosed type of A.C. motor, which, while reasonable in size and cost, is at the same time completely enclosed from any form of dust, that the totally-enclosed frame-cooled motor has been developed.

The "Witton" frame-cooled motor (made at the Witton Engineering Works of the General Electric Company, Ltd.) is built on the usual lines so far as the core and windings are concerned, but with a shell of special construction designed to give efficient cooling. The shell consists of a double wall casting, the annular space between the two walls being divided into sections by ribs to form ventilating ducts.

The inside of the inner wall is bored out to hold the stator stampings. In the centre of the shell the greater part of the back of the stampings is exposed to the air flowing in the shell ducts. The ducts are arranged to form two entirely separate circuits for air flow, adjacent ducts being in different circuits. The internal air circuit is formed by (*a*) a set of alternate ducts, (*b*) the axial ducts in the rotor core, or alternatively holes in the hub, and (*c*) the space at each end between the brackets and end winding. Air is blown round this internal circuit by a fan fitted at the driving end of the machine, and scrubs the exposed surfaces of the stator and rotor and windings, from which it absorbs heat. During its passage through the stator internal ducts, this air scrubs the ribs, which are kept cool by the air in the adjoining vent duct which is in the external circuit. Thus the air in the internal duct gives up its heat before circulating round the machine again.

The external circuit consists of the external ducts through which cool air is forced by a second fan; this air scrubs the back of the core and the walls of the ducts, from which it absorbs heat as mentioned above, and is then exhausted through holes in the end-bracket. By keeping the core cool, a temperature gradient is maintained between the slot portion of the stator coil and the core, resulting in a flow of heat from the winding, which is thus maintained at permissible temperatures.

By the use of this ventilation scheme in two circuits, arrangement is made for cooling all parts of the motor, and there is, moreover, no possibility of air remaining stationary in any part of the machine. On the contrary, it is continually in motion in a definite path carrying heat from the centre of the machine to the outside. It should be noted that stationary air is a bad conductor of heat.

In addition to the explanation of the cooling system adopted, the following points relating to the general arrangement are of importance. The fans are fitted on the rotor in such a way as to leave both bearings accessible from the outside, making the dismantling and re-assembly of the machines a very simple matter. The exhaust openings for the external air are arranged with a clear opening, as seen in the illustration, and thus the external ducts can be cleaned out with a flue brush when necessary, without disturbing any part of the motor. The slip rings are in totally enclosed covers outside the bearing.

Motors are rated in accordance with B.S.S. 168/1926, and the temperature rise will not exceed 50° C. after a continuous run on full load for six hours. They are capable of maintaining the following momentary overloads: 50 p.ct. overload in torque for one minute; 100 p.ct. overload in torque for 15 seconds.

A Coke Cooker Extraordinary.

We have received particulars of a coke cooker which, providing full service for a household of sixteen, has a stated annual consumption of 25 cwt. of coke. Known as the "Aga," this cooker burns continuously, day and night, and is thus always available for use. The inventor is Dr. Gustaf Dalén, an eminent Swedish scientist.

The cooker provides a boiling plate large enough to accommodate three vessels at a time, a simmering plate, a quick oven for roasting and baking, and a spacious cooking oven; and about 10 gallons of almost boiling water.

Owing to its insulation, the thermal efficiency of the cooker is 84 p.ct. An unusually small fire serves to heat a massive cast-iron barrel within the cooker; and this barrel, by means of an automatic draught control, is kept at a specific and very high temperature day and night. A small chamber, directly connected with the flue exit, carries a constant supply of hot air up the chimney, and eliminates danger of downdraught or fumes.

The "Aga" is manufactured and sold by Bell's Heat Appliances, Ltd., formed in June, 1931, and virtually an associated Company of Bell's Asbestos and Engineering Supplies, Ltd. (157, Queen Victoria Street, London, E.C. 4).

Trade Notes.

Order for Benzole Plant.

The Directors of the Croydon Gas Company have accepted the tender of Messrs. Simon-Carves, Ltd., Cheadle Heath, near Manchester, for the installation of a complete benzole plant for the production of motor benzole from 3½ million c.ft. of gas per day.

Refractories Bulletin.

Messrs. John G. Stein & Co., Ltd., have commenced publication of a series of Monthly Bulletins, in the hope that presentation of some of the interesting features connected with silica and fireclay refractories will be of service to users. The January issue takes the form of a glossary of terms relating to the subject.

Bell's Asbestos and Engineering Supplies, Ltd.

This firm have forwarded their new general catalogue covering the whole of Bell's asbestos products together with Bell's engineering supplies, including gas tubing, gas bags for mains, and so on. This catalogue is extremely well produced, and should prove of real service in such matters as packing, jointing, insulations, conveyor and elevator problems, steam lines, and small tools.

Davis Gas Stove Company, Ltd.

On Saturday, Jan. 16, the Davis Gas Stove Company, Ltd., changed their Offices, and with them their associated concern, the Nautilus Fire Company, Ltd. All communications should therefore now be addressed to the new Registered Offices and Showrooms at 7, Stratford Place, W. 1. Telephone: Mayfair 6462: telegrams: "Degasco" (or "Nautifico"). Wesdo, London. The new premises—an original Adams building—are situated in the heart of the fashionable shopping district, and within a minute of Bond Street Underground Station (Central London Railway).

SPIRAL GASHOLDERS

By S. M. MILBOURNE, A.M.I.Struct.E.

A brief treatise investigating from a mathematical standpoint, as far as possible, the main loads and stresses induced in the various members which constitute the spiral guided gasholder. The determination of the actual sections required to safely withstand these loads is then a matter of arithmetical computation and practical experience in design

The spiral gasholder was introduced by Messrs. Gadd & Mason about 50 years ago, and since the first two-lift holder of this kind was erected at Northwich about the year 1890 gradual improvement in the design has had the effect of making this type of gasholder one of the most popular in Great Britain and the Colonies at the present day.

The essential features of the spiral gasholder are that the bell and lifts are each fitted with a number of guide rails attached to the side sheeting and vertical stays at equal distances round the circumference of each lift. These rails are attached to the outside of the sheeting and inclined at an angle of 45° with the horizontal. Guide roller carriages are fixed to the top curb or balcony of the tank and also to the dip of each lift, and these are so arranged that the spiral rails on the floating portion of the holder are practically in constant contact with the rollers when the holder is being inflated or deflated. Each roller carriage is fitted with at least two rollers, one on each side of the guide rail. Stability of the floating structure against overturning is thus maintained by the resistance offered to any upward, downward, or lateral movement of the guide rails, by the rollers at each carriage.

The chief advantages of the spiral holder over the guide framed holder may be briefly enumerated as follows:—

(*a*) Cheaper in design.
(*b*) Lower cost of painting.
(*c*) No permanent guide framing.
(*d*) Increased pressure due to heavier construction of floating portion of structure.
(*e*) No internal rollers.

Stability of Flotation.

When considering the question of stability, it is necessary to observe the conditions under which a gasholder will remain stable when subject to its own weight only, no consideration being given to external influences such as the overturning moment of the wind, snow load, or the support offered by the roller carriages.

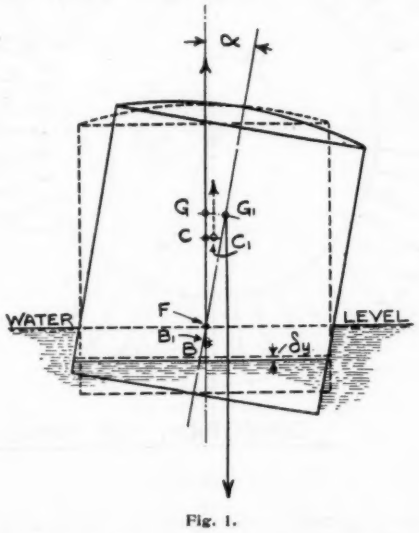


Fig. 1.

Fig. 1 represents the floating bell of a gasholder nearly fully inflated. The difference in water level inside the holder to that in the tank is purposely exaggerated in order to bring out more clearly the positions of the various forces which tend to influence the stability of the complete structure.

The conditions of stability for a holder inflated with air and floating freely on the surface of perfectly still water are as follows:

(1) That the weight of water displaced equals the weight of the floating holder.

(2) That the centre of gravity (G) must be in the same vertical line as the centre of gravity of the water displaced (B) (centre of buoyancy).

(3) That the centre of gravity (G) must be below the centre of flotation (F) (the point about which the holder will tilt).

Now suppose the holder to be inflated with air and inclined at a small angle α from the vertical as in fig. 1. It will be seen that the centre of gravity (G) is moved by a proportionate amount from the vertical to the position G_1, with the result that a couple is set up, tending to overturn the structure. This consists of a downward force equal to the weight of the holder acting through G_1 and an upward force of equal magnitude acting through the centre of buoyancy (B). The directions of these couples are indicated by arrows in fig. 1. It will be noticed that the water line inside the holder remains level after tilting has taken place; therefore, the centre of buoyancy is unchanged and remains in its original position mid-way between the surfaces of the water outside and inside the holder.

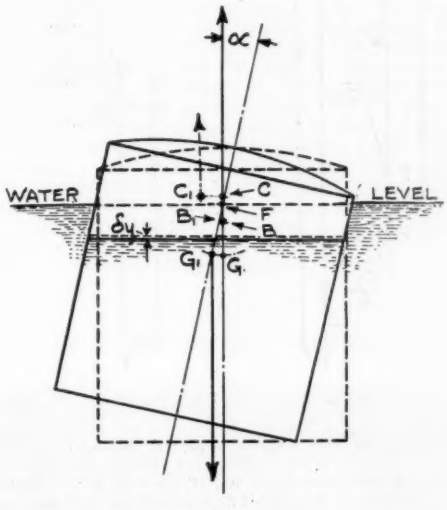


Fig. 2.

In the case where the bell is only slightly inflated by air, as indicated in fig. 2, the position of the centre of gravity will fall below the centre of flotation. By examining the moments of the couple which is set up, it will be seen that the holder is in a state of stable equilibrium, since the couple tends to pull the structure back again to the vertical position after tilting. If the inflation is allowed to proceed, a point is eventually reached where G coincides with F, and at this stage the structure is in indifferent equilibrium. That is to say, the holder will remain (theoretically) in any position in which it is tilted, there being no couples in action tending either to right or overturn the structure.

The foregoing remarks refer only to the stability of the holder when inflated with air. When the holder is inflated with gas, however, a slight modification is necessary to determine the force systems influencing the stability of the structure. It will be readily understood that when the bell is inflated with gas there is not only the buoyancy of the water to take into account, but also the lifting effect of the gas. This lifting effect acts through the centre of buoyancy of the gas volume (C) which is situated about the centre of that portion of the holder remaining above the inside water level. Its influence on the moments set up in the inflated holder is shown in figs. 1 and 2 by the short arrow line shown dotted. In fig. 3, the moments in fig. 1 are reproduced to an exaggerated scale, and it will be seen therefore that the tendency of the gas on the fully

inflated holder is to decrease the instability of the holder from wg to $(w-b)\,g-bc$

where w = the weight of the floating structure.
b = the buoyancy of the gas.
c and g = the distances of the virtual lever arms.

It will also be observed that when the holder is inflated with gas instead of air, the water level inside the holder will rise as the weight of the structure is somewhat relieved by the buoyancy of the gas. This rising of the water level is indicated in fig. 1 by a dotted line shown at a distance δy above the original level. Therefore, the centre of buoyancy of the water (B) will now be raised to (B_1), a distance of $\frac{\delta y}{2}$ This alteration in the position of B has no influence on the condition of the moments other than reducing the weight of the floating holder which acts through points G or G_1 by an amount equal to the gas buoyancy. This reduction is shown by a portion of the load vectors indicated by dotted lines in fig. 3.

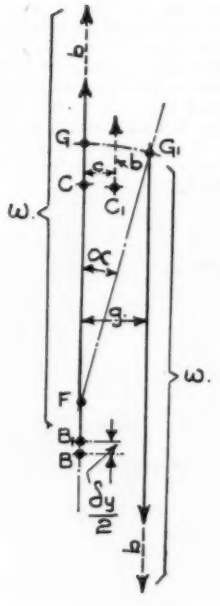


Fig. 3.

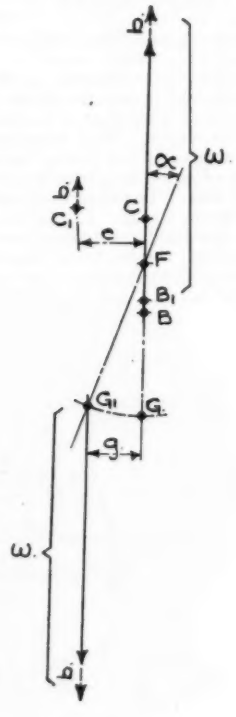


Fig. 4.

In the case of the holder slightly inflated as shown in fig. 2, the buoyancy of the gas tends to decrease the stability of the holder from wg to $(w-b)\,g-bc$ (see fig. 4). This is the same expression (algebraically) as that obtained for the fully inflated holder, but it will be noticed that in one case the instability is decreased, while for the other the stability is decreased.

When the gasholder consists of two or more lifts, the same principles apply so far as the stability of the structure is concerned. As the holder is gradually inflated, the various lifts are cupped and taken up with the bell. They may then be considered rigidly connected with the floating structure, since tilting of the inner lift cannot occur without similar tilting of the second and following lifts. In actual practice the tilting tendency of the inflated holder is assumed to take place in the plane of the tank rollers, which is usually a few inches above the water level in the tank.

Wind and Snow Load.

When a gasholder is inflated, the question of stability, so far as its own weight is concerned, is usually neglected, as under working conditions the horizontal distance from the centre of gravity of the floating structure to the centre of flotation is not sufficient to produce any appreciable moment. Under the action of wind and snow, however, the overturning moments induced are considerable. It is usual to assume a weight of snow equal to 5 lbs. per sq. ft. over the surface of the crown sheeting. This allowance includes for snow several inches in depth, waterlogged with rain, which is the most unfavourable condition likely to be experienced in this country. When the gasholder is at rest in the tank and the crown sheeting is not under the influence of internal pressure, the weight of the snow is transmitted by the crown framing to the centre pier and vertical stays of the inner lift. After the holder is inflated, however, the crown sheeting is lifted off the framing by reason of the tensional stress induced in the sheeting, and the snow load is resisted by a proportionate increase in gas pressure. If the snow is uniformly distributed over the crown, no overturning moment is set up, but if the snow drifts so that it becomes deeper on one side than on the other, the unsymmetrical loading tends to overturn the structure. A snow load of 5 lbs. per superficial foot, evenly distributed over one-half the crown only, is therefore assumed. The moment (m) set up may then be expressed as follows:

$$m = \cdot 424\, rS \qquad (1)$$

where r = the radius of the holder,
S = the total weight of snow on one half of the crown.

The pressure exerted by the wind, however, is far the greater influence tending to overturn the inflated holder, and this will now be considered.

From experiments carried out by Dr. T. E. Stanton, of the National Physical Laboratory,* it has been ascertained that the relationship between the direct normal wind pressure in lbs. per square foot (p) and the velocity in miles per hour (V) are connected approximately by the formula $p = \cdot 003\ V^2$.

Then since the maximum wind velocity which is likely to be experienced in this country is about 108 m.p.h., it follows that by substituting this value in the above expression p = 35 lbs. per square foot. There is, however, reason to believe that the full influence of this pressure is never realized on the whole of the structure at one time, as the wind travels in gusts of comparatively short duration, and its maximum influence is maintained over small local areas only. From experiments respecting the behaviour of wind on gasholders it has been found that not only is a wind pressure exerted on one side of the structure, but a partial vacuum or suction is also set up which acts over an area of the side sheeting bounded by more than three-quarters of the circumference of the floating holder. The distribution of wind pressure and suction is not amenable to simple mathematical computation, but has been ascertained experimentally (by J. O. V. Iminger, of Copenhagen, R. Sonntag, A. G. V. Baumhauer, and others) to vary in the manner indicated in fig. 5.

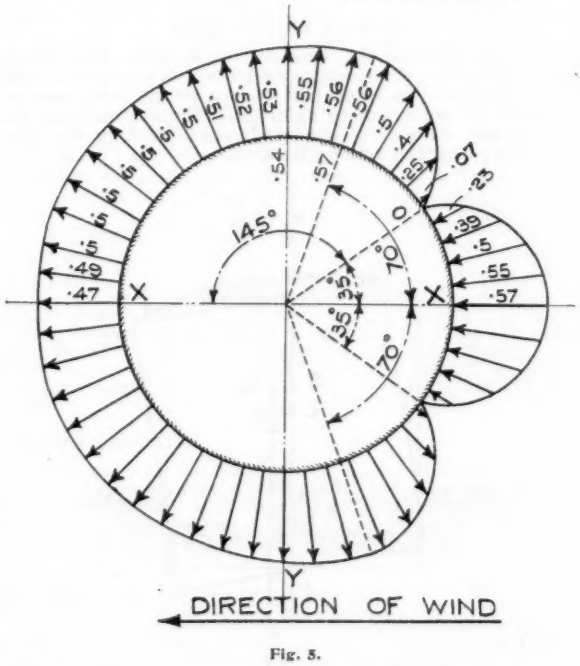


Fig. 5.

The force vectors representing the wind pressure and suction coefficients on the side sheeting of a gasholder at 48 points equidistant round the circumference are given in fig. 5 in terms of the direct normal wind pressure. It will be seen that the actual wind pressure is exerted on a segment of the cylindrical vessel, subtended by angles of 35° with the axis of the wind, while the remaining 145° is under the action of a partial vacuum.

Then by resolving the normal pressure and suction into the direction of the wind, the total value of the wind load P may be obtained. In the case of Iminger's experiments,

* "Experiments on Wind Pressure," paper No. 3695, Inst. C.E. Proceedings.

this was found to be

$$P = \cdot 57\ DNdp \quad \ldots \quad (2)$$

where p = the direct normal pressure of the wind per square unit,
D = the mean diameter of the holder,
N = number of lifts inflated,
d = effective depth of each lift.

The total overturning moment (M) of the wind on the inflated holder will therefore be

$$M = \frac{\cdot 57\ DN^2pd^2}{2} \text{ or } \cdot 57\ N^2rpd^2 \quad \ldots \quad (3).$$

From observations of the action of the wind on the crowns of gasholders, it has been shown that a suction exists over the entire area. The intensity of the suction has been found to be almost constant over the surface of the sheeting. In one instance, the reduction in pressure thrown on a gasholder of large diameter when subject to high winds was observed to be over 2·2 lbs. per square foot. As the resultant of the suction force on the crown is practically vertical, no overturning moment is induced, and therefore the question of wind suction on the crown does not enter into the calculations.

(To be continued.)

IN CONTINENTAL COUNTRIES - - -

Abstract Translations from the Technical Press of France and Germany.

INVESTIGATION OF THE LOW-TEMPERATURE CONDENSATES FROM TOWN GAS.

According to K. Bunte and F. Steinbrunn, "Das Gas- und Wasserfach," 1931, 74, 1193-1195 (Dec. 26), no explanation has hitherto been possible as to the cause of the sticking up of meter valves since the deposits on the valves and valve chambers are too small for investigation. An investigation was therefore carried out on the composition of the low-temperature condensates obtainable from gas since the compounds responsible for the troubles must be present in these condensates.

The material examined was obtained at the low-temperature installation of the Berlin gas-works by strongly cooling the purified town gas. The product obtained at a temperature of −4° Fahr. was examined with the following results:

Initial boiling point 88° C., criterion 121, fractionation criterion 50.

Present.—Pyridine bases 1·51 p.ct., combined sulphur, pyrrole (in the 90°-150° C. fraction), aniline (in the 180°-190° C. fraction).

Absent or not Detectable by the Test Mentioned.—Phenols (Lassar method), naphthalene (Schläpfer-Flachs method), corrosive sulphur compounds (copper-strip test), indene (in the 170°-190° C. fraction).

Acid Wash Test.—Very dark colour—beyond range of the standard colour scale.

Bromine Value.—5·25 grammes bromine/100 c.c.

The distillation characteristics of the liquid were not altered after 12 hours' refluxing on the water-bath (1) alone, (2) with filings from a meter valve, (3) as last, but in a current of oxygen.

Also, there was no alteration of the distillation characteristics when the oil was refluxed at the boiling point on a sand-bath (1) for 12 hours with 0·7 p.ct. of flowers of sulphur, (2) for 8 hours with brass filings.

A distillation residue comprising 35 p.ct. of the oil and showing an initial boiling point of 132° C. with 90 p.ct. over at 207° C. was obtained by fractional distillation with a good column to eliminate constituents boiling below 120° C. This residue contained phenols 1·6 p.ct., pyridine bases 2·8 p.ct., naphthalene (Schläpfer-Flachs method) 2·8 p.ct., pyrrole, aniline, coumarone, and combined sulphur compounds.

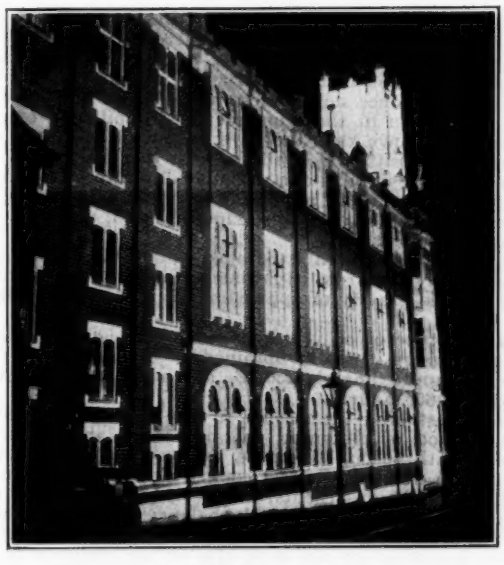
The original oil, on filtration, gave a small amount of a thick black, sticky mass. This was freed from adherent oil in a strong current of air, and then yielded a rather brittle mass resembling agglomerated soot. It burnt with strong swelling and yielded a ferruginous ash. The material was extracted with hydrochloric acid, and in the resulting extract ammonia, sulphide, carbonate, and iron were found. The residue from the extraction contained free sulphur, evolved ammonia on being heated, and gave a yellow sublimate of sulphur. The presence of a polymerized pyrrole product is therefore likely.

Though constituents are present which could give rise to resin formation, the bulk of the oil is composed of stable compounds. Comparison of the original oil with the 35 p.ct. residue obtained by removing the fractions boiling below 120° C. leads to the following conclusions:

Naphthalene was not recognizable by the Schläpfer-Flachs test in the original oil owing to the disturbing effect of benzole. In the 35 p.ct. residue it was present in rather high concentration. The phenolic constituents were only recognizable after a relatively great degree of concentration had been effected and are thus mainly those of high boiling point. Since the relative concentrations of pyridine bases were 1·51 p.ct. in the original oil and 2·8 p.ct. in the 35 p.ct. residue, higher homologues must mainly be present, though a certain amount of pyridine itself must also be present. As regards sulphur compounds, both thiophene and compounds of higher boiling point are present. The only unsaturated compound recognized by a specific test was pyrrole. Though it was found only in small amount, it is conceivable that it was present in the fresh oil in much greater concentration since the compound is unstable and readily condenses and polymerizes, and the oil was not quite fresh when examined. Moreover, the material deposited from the oil was a nitrogenous polymerization product. Coumarone, also, readily resinifies. The sulphur compounds present may, due to their reactivity, play a part in effecting polymerization, but whether by catalysis or in some other way was not ascertainable.

Of compounds in Berlin town gas which might give rise to troubles in meter valves, pyrrole and coumarone were recognized in the low-temperature condensates. The authors conclude that the presence of these substances cannot be the sole cause for the sticking up of the valves since they are present in such small amount.

Floodlighting at Coventry.



The new Central Hall, Coventry, which was opened on Thursday last, floodlighted by gas giving 14,400 c.p., and costing only 1s. per hour. The brickwork and the white stone are revealed in their natural tones. The tower is illuminated by electricity, and the advantages of the softer gas lighting can be plainly seen. The Coventry Gas Department (General Manager, Mr. P. N. Langford) have every reason to be satisfied with the results of their efforts.

THE "JOURNAL" TECHNICAL RECORD

Which contains Reports of Meetings of Gas and Allied Associations

A Study of the Problem of Naphthalene Removal

By Benjamin Thorpe, M.Inst.Gas E.

[Extract of a Thesis, presented at a Meeting of the Yorkshire Junior Gas Association, Jan. 16, which gained the Author the Diploma of the Institution of Gas Engineers]

Introduction.

It is my intention in the following extract of a thesis to present a summary of a series of investigations which I have carried out on problems directly in connection with the removal of naphthalene and the cause and the remedy of the deposition of gums from coal gas.

It is proposed in this paper to study chiefly the removal of naphthalene by washing with oil, which has been the most widely adopted method and has been found to be the most systematic and thorough means of dealing with naphthalene in gas. Briefly, the principle is to reduce the partial pressure of naphthalene in the gas to a figure which will be so low as to be quite incapable of causing a naphthalene deposit under any temperature conditions which are likely to be found.

The naphthalene washer at the Huddersfield Gas-Works consists of a Holmes rotary brush washer of 12 ft. diameter with six washing cylinders, this being driven by a steam engine through ordinary spur gearing.

The type of wash-oil to use is a matter of opinion, and depends on whether solvents are produced at the works. The solvents may be summarized as follows:

(*a*) Coal tar creosote, or anthracene oil free from naphthalene.

(*b*) Middle oil fraction of low-temperature tar, or vertical retort tar.

(*c*) Gas oil (petroleum distillate).

(*d*) Scotch shale oil.

(*a*) This type of oil, so long as it has been stripped of naphthalene, should prove satisfactory. The specific gravity should be in the region of 1·020 at 60° Fahr., and the oil should not boil below 200° C. The tar acids are an advantage since naphthalene is much more soluble in these acids than in the remainder of the oil, and experiments have shown that they are an advantage in regard to gummy deposits, which will be dealt with later.

(*b*) This type of oil is of a paraffinoid nature, is free from naphthalene, contains approximately 20 p.ct. tar acids, has a specific gravity of approximately 0·95, and does not boil until about 220° C.

(*c*) This is undoubtedly the most satisfactory absorbent, being entirely free from naphthalene; it is of high fluidity, has a specific gravity of approximately 0·860, and boils at 220° C.

(*d*) This type of oil is the least used of the four, but is employed where it can be obtained at a competitive price. It boils at approximately 230° C., and has a specific gravity of 0·840 at 60° Fahr.

Before installing the washer it was necessary to devise some method of obtaining the properties and power of wash-oil with special reference to the economic use and the cost. A number of direct comparative tests were made on the different absorbents, on the actual gas itself, and there could be no doubt that the balance of the advantages lay with ordinary gas oil as an absorbent for naphthalene.

Some investigation was done also on the accuracy of the ordinary methods of test for naphthalene in coal gas and for naphthalene in the gas oil. It was found that one of the simplest methods hitherto proposed gave results with at least as high an accuracy as others which incorporated various precautions, and this method is the familiar one in which the picrate precipitate has to be collected on the smallest possible filter paper, is boiled with water to make up the compound and expel the naphthalene, after which the free picric acid remaining is titrated. In particular, it may be mentioned that artificial mixtures of naphthalene in gas oils were found to yield good condition results by dissolving the oil in a little acetone and precipitating directly with picric acid solution, filtering off and treating as above mentioned.

Before washing for naphthalene it was the writer's experience to have difficulty in keeping holder inlets and outlets clear of naphthalene. It was the practice to seal off each holder inlet and outlet once per month with benzole, and one particular test gave a recovery of 281·09 lbs. of naphthalene.

The most immediate results of the elimination of naphthalene from the outgoing gas was the clearing of the holder inlet and outlet pipes. The clearing up of the outer districts was a more lengthy process, and may be considered to have occupied not less than 18 months. Some charts are given (figs. 1, 2, and 3) showing the naphthalene content

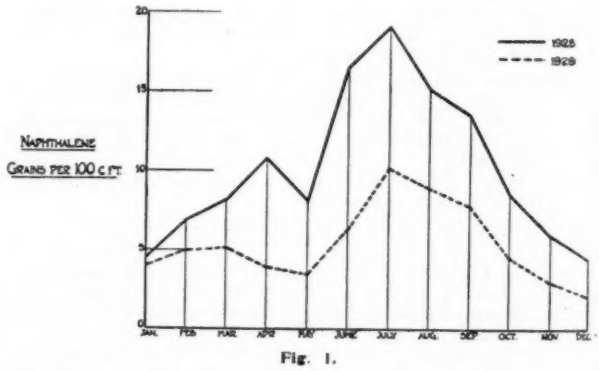


Fig. 1.

at different times of the year, and the numbers of stoppages per month experienced for three successive years, including one year before and two years after naphthalene washing was put into operation, and the washing efficiency of the washer over a period of twelve months.

Re-conditioning Wash-Oil.

At the time the experiments on the characteristics of different wash-oils were in progress I began to investigate the possibilities of re-conditioning the wash-oil for use in a washer, and the conditions which would have to be satisfied for this to be a successful undertaking.

This work was undertaken partly at the instance of Messrs. W. C. Holmes & Co., Ltd., who were anxious to construct a plant for this purpose. There was to us no attraction in having gas oil on the works, as we do not make any carburetted water gas. Consequently all the used oil was at first disposed of and new oil bought to put in the washer. It will be seen that the regeneration of the oil is quite capable of justifying itself on the saving in gas oil cost to such works as are not able to use it for gas making.

Another aspect of the experimental work which was done in addition to that above described was concerned with deposits of another character, which had been found in our works, chiefly on the large station governor valves. This was a gummy or resinous substance which, although small in quantity and slow in growth, was found to be capable

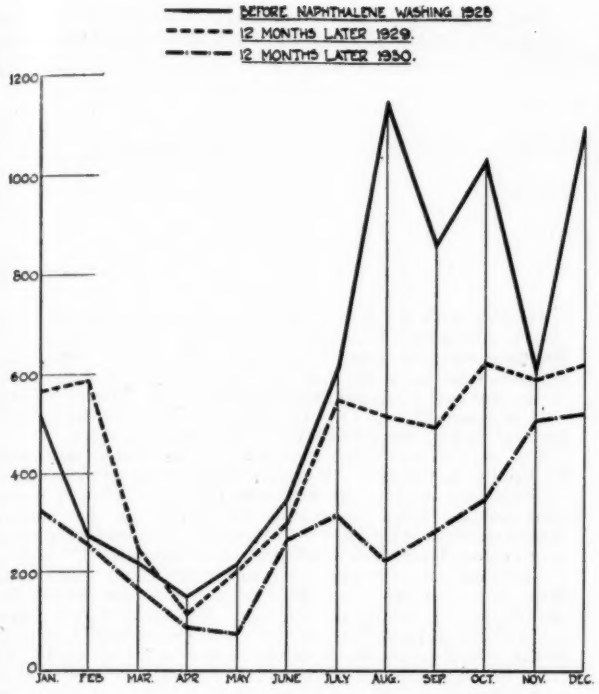


Fig. 2.

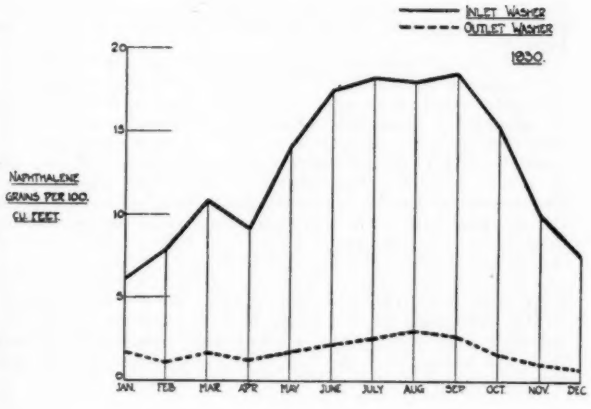


Fig. 3.

of causing sticking of these valves, requiring their dismantling and cleaning out.

A large amount of work was done on this material, and data were collected from a number of sources.

The gum is black or brown in colour, and, though soft and plastic at first, hardens rapidly in the air into a pitchy matter. I found it to be an oxidation product formed from some unsaturated compounds in the gas, although the mechanism of the formation, and the reason why it appears to be connected with the practice of washing naphthalene from gas, are not clear.

The best explanation which appears to cover the facts is that the wash-oil not only extracts the naphthalene from the gas, but extracts another substance which has hitherto been preventing the formation of the gum. It has also been suggested that the inhibiting substance is phenol or cresol vapour. It has, however, been found to be the case that a number of other undertakings have had experience of gum formation who have not hitherto removed any naphthalene. It appears to have been liable to occur under war-time conditions, possibly owing to the high oxygen content of the gas, which certainly has some influence on its formation.

Apparently almost any of the unsaturated substances which may be present in the gas have some possibility of forming gummy bodies by polymerization and by oxidation. Some of these substances are well known in this connection, but others are not so easily detected. The best known ones are hydrocarbons of high boiling-point, ranging between 146° and 170° C., and we have shown that a gummy material apparently identical with that actually removed from the gas system can be prepared by the polymerization and oxidation of the fraction of our crude benzole which contains these particular substances.

Comparison of the Gums (Deposit on Governor and those Made in Laboratory from Condensation and Oxidation of the Fraction 135°-200° C. from Spent Gas Oil).

Property of Reaction.	Deposit.	Prepared Gums.	
		Condensation.	Oxidation.
Heated in test tube.	Does not melt; cokes evolving yellow vapours which condense to a dark yellow liquid; coke burns very readily	Melts; distilled evolving vapours condensing to a colourless liquid eventually clear	As deposit
Plus conc. H_2SO_4 *plus* heat . . .	Dissolves to a deep red liquid and finally clears with evolution of SO_2	As deposit, but not so readily	,,
Plus benzene-solution treated with aqueous picric acid	No action	White precipitate in oil layer	,,
Plus phenol . . .	Soluble	Slightly soluble	,,
Plus NaOH, 10 p.ct.	Soluble	Insoluble	,,
Plus Na_2CO_3 . .	Slightly soluble	Insoluble	,,
Plus acetone . .	Very readily soluble	Soluble	,,

In a paper published by the Koppers Research Corporation of Pittsburgh, America, the following analysis is given of the hard gum deposits from coke oven gas, which is evidently identical with those which we have been considering:

Carbon	60·00 p.ct.	by weight
Hydrogen	5·72 ,,	,,
Oxygen	27·48 ,,	,,
Nitrogen	5·85 ,,	,,
Sulphur	0·45 ,,	,,
Ash.	0·50 ,,	,,

The high proportion of oxygen in this gum is very interesting and important, and it is obvious that this oxygen must be partly derived from the free oxygen in the gas, although, of course, the oxidation becomes much more rapid when the gum is exposed to the air for examination.

The idea, therefore, arises that if by the use of an oil washing plant we can eliminate the naphthalene, what condition should be prescribed for the removal of the unsaturated compounds, particularly those of high boiling-point.

It was realized that a very considerable increase in the rate of the passage of the oil through the washer would be required, and this was allowed for. The regeneration of the oil must be carried on at exactly the same rate, and the oil must be brought into such a condition that its power for removing naphthalene and the unsaturated bodies was, for practical purposes, at the maximum.

Regenerating Plant.

In the plant the oil is pumped first through a preheater, afterwards through a distilling column, wherein it meets a current of live steam which carries away the naphthalene and other bodies, along with a certain amount of benzole which is naturally extracted at the same time. The oil which leaves the still is, after cooling, ready for immediate passage back to the washer, as the whole of the treatment has been carried out at a temperature above 100° C., and therefore there is no deposition of water from the steam.

It is presumed that the bodies which are to be extracted from the gas are those of high boiling-point. The vapour is, therefore, fractionated into two parts by means of a fractionating condenser and a scrubbing column, so that the naphthalene and other heavy hydrocarbons are found in the first deposited fraction, and the crude benzole, which is found to be of a very good quality, is passed on to a further condenser and taken off as another fraction. We could, of course, have returned the benzole to the gas without presumably returning any of the injurious bodies therewith. We found, however, that once the benzole was obtained, it was more profitable to retain it as such than to return it to the gas, on the valuation of our cost per therm into holder. It may be mentioned that the amount of this benzole was between 80 and 100 gallons per day, on a stream of gas varying between 3½ and 5 million c.ft. per day.

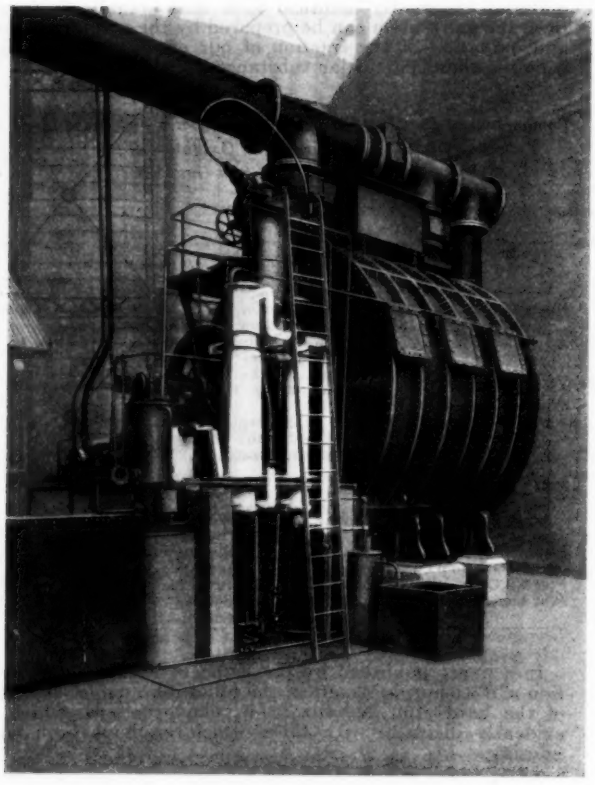


Fig. 4.—Wash-Oil Regeneration Unit.

The distillation range of the wash-oil, heavy fraction, and the light fraction are given herewith:

24-Hour Test on the Oil Recovery Plant.

Naphthalene at washer inlet . . . . 10·340 grains per 100 c.ft.
,, ,, ,, outlet . . . 0·988 ,, ,, ,,
Gas made, 3,650,000 c.ft.; coal carbonized, 256 tons.
Naphthalene extracted, 48·76 lbs.
Steam used in recovery plant, 41·3 lbs. per hour (exhaust).
Thermostat working between 130° and 136° Fahr.

—	Benzole.	Intermediate Distillate.	Recovered Oil.	Spent Oil.
Sp. Gr. at 60° Fahr. .	0·874	0·870	0·850	0·855
$C_{10}H_8$ by wt., p.ct. .	0·000	15·54	1·87	2·87
Gallons	96	43	720	859 (calc.)
Gallons per hour . .	4	1·79	30	35·79 ,,
Distillation, p.ct.—				
To 80° Fahr. . .	4·0	..	..	..
90° ,, . .	13·0	..	..	1·0
100° ,, . .	46·0	..	..	2·5
110° ,, . .	63·0	..	..	4·5
120° ,, . .	72·0	4·0	..	7·0
130° ,, . .	81·0	9·0	..	9·5
140° ,, . .	91·0	15·0	..	11·5
150° ,, . .	..	25·0	..	12·5
160° ,, . .	..	35·0	..	13·5
170° ,, . .	..	45·0	..	15·0
180° ,, . .	..	55·0	..	16·0
190° ,, . .	..	63·0	..	17·0
200° ,, . .	..	69·0	4·0	18·5
210° ,, . .	..	76·0	6·0	19·5
220° ,, . .	..	82·0	7·5	21·0
230° ,, . .	..	90·0	10·0	23·0
240° ,, . .	..	Naphthalene at 220° C.	12·0	28·0
250° ,, . .	..	..	17·0	35·0
260° ,, . .	..	..	23·0	43·0
270° ,, . .	..	..	35·0	49·0
280° ,, . .	..	..	45·0	62·0
290° ,, . .	..	..	55·0	72·0
300° ,, . .	..	..	68·0	77·0
310° ,, . .	..	..	77·0	90·0

Benzole recovered per ton of coal carbonized $\frac{96}{256}$ = 0·375 galls.

Other hydrocarbons ,, ,, ,, $\frac{43}{256}$ = 0·168 ,,

Naphthalene recovered ,, ,, ,, $\frac{58·135}{256}$ = 0·227 lb.

The following is a balance-sheet showing the financial statement for the production of 100 gallons of benzole per day.

Balance-Sheet.

	£ s. d.		£ s. d.
100 galls. of benzole at 9d.	3 15 0	Value as gas	1 15 4
		Interest and depreciation .	0 3 8
		Labour	0 4 6
		Mechanical repairs. . .	0 1 1
		Water	0 0 3
		Oil.	0 0 1
		Profit or balance . . .	1 10 1
	£3 15 0		£3 15 0

Dealing with the saving in wash oil only, we find that one year's consumption would, on the old system, have been 20,000 gallons, at a net cost of 1½d. per gallon. This is the difference between the cost of new oil, 3½d., and the value of the used oil when run into tar well at 2d. Therefore, the cost of wash oil was £125 per annum. This saving has not been placed in the credit side of the balance-sheet.

The actual results on the distribution system may now be briefly mentioned. We have found it possible to get a naphthalene content on the outgoing gas below 2 grains continuously while operating the plant in the manner stated above. The question, however, of proof of prevention of gum formation is a little more difficult.

The condition of our governor valves has apparently been much better, and, in fact, during the recent few months has given us no trouble. The slow growth, however, of these deposits in the past and the difficulty of proof of the actual origin of the gums, makes it necessary to give time for a complete demonstration that the removal of gum-forming substances is complete. I have shown, however, by actual experiment that it is not possible to make, by polymerization or condensation from the gas oil constituents, any gum in any way resembling those formed on the governors. On the other hand, I have successfully prepared similar gums from the heavy fractions of the crude benzole.

Similarly, I have demonstrated that the gas leaving our oil washer is substantially free from the heavy boiling constituents which may contain unsaturated hydrocarbons of the character suspected. This was done by actually stripping the samples of gas with the active carbon test apparatus. An examination of the constituents of the sample of crude benzole thus obtained shows clearly a large diminution in the higher boiling constituents as well as in the naphthalene. For example, the crude benzole at the inlet of the washer showed 81 p.ct. at 100° C., while that at the outlet showed 90 p.ct. at 100° C., at the inlet 91·5 p.ct. at 120° and the outlet 96 p.ct. at 120° C. These were from tests done in exactly the same manner at the same time.

The difference in the total benzole content of the gas entering and leaving the washer also corresponds closely with the volumes of the two fractions which are obtained from the plant.

Conclusions.

The scrubbing-out of hydrocarbons from coal gas is open to objection, inasmuch as these hydrocarbons have considerable calorific value, and their removal reduces the calorific value of the gas.

In most works (horizontal retorts) it is a necessary part of the gas-making process to reduce the high calorific value of the gas made to that standard required by the Gas Regulation Act.

Methods Adopted.

(*a*) Producer gas.

(*b*) Air.

(*c*) Washing the gas for the recovery of benzole, naphthalene, and gum-forming hydrocarbons.

I have shown that process (*c*) is the most economical: from a financial and national standpoint it is the best method.

(*a*) and (*b*) are inerts, and the question might be asked: Why add inerts to the gas which has to pass through a gas supply system which is not in excess of the normal requirements, and the prospects of supplying an ever-increasing demand through that system in therms per hour, when we can reduce the calorific value without such addition?

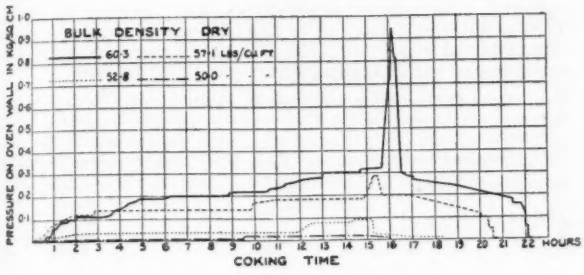
The addition of air to gas for dilution purposes brings us to the point of creating an oxidizing atmosphere, and thus the possibility of oxidizing the unsaturated hydrocarbons and the formation of gums. Thus the aim should be to reduce the oxygen content of the gas to a figure as low as possible.

Intermittent Vertical Chambers: Some Recent Developments

By L. H. Sensicle, B.Sc., F.I.C., Gas Chambers and Coke Ovens, Ltd.

[From a Paper at the Third International Conference on Bituminous Coal, Pittsburg, November, 1931]

(*Concluded from p.* 147.)



Swelling Pressure Curves of a Coal charged at four different Densities—for use in conjunction with Table III. ("JOURNAL" for Jan. 20).

Recent Types of Vertical Chamber Oven Installation.

Apart from the different types of chamber available there are a number of variations possible in installations of any one make of plant. [In the paper four different types of C.O.L. vertical chamber installations were illustrated.]

(1) Chamber settings with built-in step-grate producers, air recuperation only, and waste-heat boiler installation.

(2) With external mechanical producers supplying cold, clean gas to the chamber heating walls via gas recuperators (air recuperators being also embodied), and waste-heat boilers installed at the producer plant.

(3) With external brick-built producers connected by insulated hot gas flue to the settings which are provided with air recuperation only and waste-heat boiler plant.

(4) Vertical chamber plant of any type fitted with coke dry cooling chambers.

The choice of producer plant depends on a number of factors in addition to first cost. Thus, in certain cases, external mechanical producers yielding cool, clean gas have overwhelming advantages—*e.g.*, where coal of high ash content is carbonized and the coke made would give rise to excessive hand clinkering charges and even dislocated working of the plant. According to E. Dubois coke of high moisture content when used in built-in or external brick-built producers supplying hot gas to the settings causes marked thermal loss owing to the lowering of flame temperature by the moisture carried in the gas, and also additional chimney losses owing to the extra water vapour discharged by the stack. These losses are effectively prevented by the use of external mechanical producers, since any excess moisture carried by the producer gas is condensed out before the supply reaches the combustion flues of the chamber oven setting. On the other hand, the general use of coke car and quenching tower at such plant should enable a coke to be made with a low moisture content, and high fuel consumption from this cause should not arise. The advantage of the third type of installation with an independent battery of brick-built producers as compared with the built-in type is well known to be the possibility of shutting-down individual producers without interrupting the heating of any of the settings, and conversely of shutting down settings without being compelled to put any particular producer out of action. C.O.L. plants of each of the above three types are represented in Table II., which gives the results of the official tests performed in each case. The figures are of special interest in view of the three different qualities of gas made—viz., 535, 485, and 470 respectively, and the very satisfactory results reflect the great flexibility of the intermittent vertical chamber system of carbonization. The results in Table II., except those on Londonderry coal, are embodied in the curves of fig. 1, which is a diagram designed to show at a glance the actual working results obtained recently at three of the most modern plants operating under different conditions on medium quality Durham coal.

The application of coke dry cooling to intermittent vertical chambers is simply effected as shown in fig. 9 by arranging for the hot coke car to run at a level sufficiently elevated to accommodate a series of cooling chambers beneath. Each cooling chamber receives a full discharge of hot coke from one vertical chamber via the coke car and is thereupon closed and communication made by inlet and outlet valves with the inert gas circulatory system. Passing up through the coke from the step-grate floor of the chamber these gases become heated and return to the waste-heat boiler of the cooling plant, which can if desired be made interchangeable with the waste-heat boiler of the carbonizing installation. The cooled gases are returned to the cooling chambers by means of a fan, and pass through the chambers in parallel flow. It may be mentioned that superheaters precede the boilers, the steam raised at one installation being at a pressure of 210 lbs. per sq. in. and

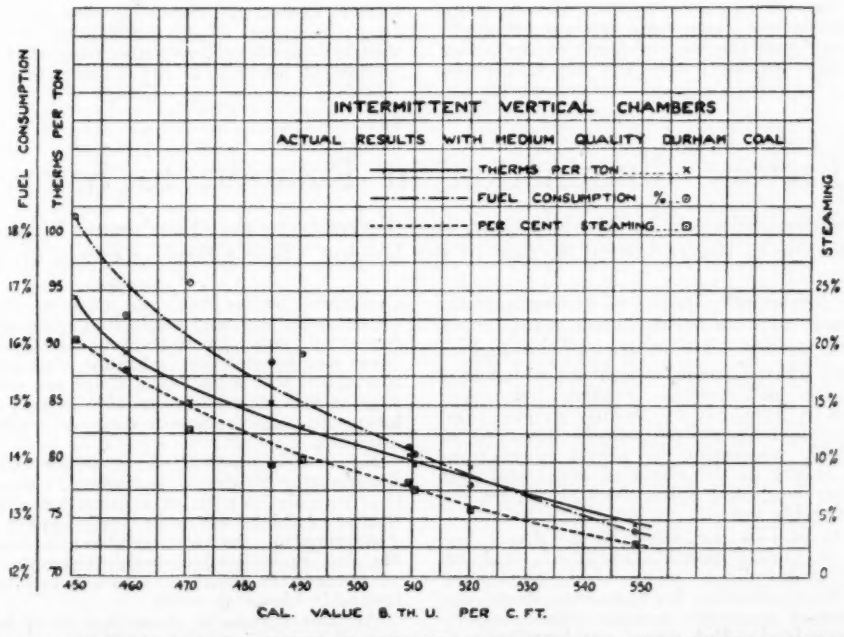

INTERMITTENT VERTICAL CHAMBERS
ACTUAL RESULTS WITH MEDIUM QUALITY DURHAM COAL
THERMS PER TON x
FUEL CONSUMPTION % .. ⊙
PER CENT STEAMING ... ⊡
FUEL CONSUMPTION
THERMS PER TON
STEAMING
CAL. VALUE B. TH. U. PER C. FT.

FIG. 1.—WORKING RESULTS UNDER DIFFERENT CONDITIONS AT THREE MODERN PLANTS.

superheated to 350° C. The yield of steam per ton of coke cooled is 900 lbs. at the pressure and superheat mentioned, and it has been found possible to exceed this figure. If it be argued that this exceeds the theoretical steam possible, its incontrovertible reality can be explained by the existence of a patented feature designed to prevent the deposition of unreactive carbon deposits on the coke. Stated briefly, the position is that small amounts of carbon monoxide are formed in those chambers recently charged, owing to a limited producer gas reaction. To remove this a controlled amount of air is added in the hot gas collecting flue, thereby converting the CO to CO_2 with the generation of some extra heat which is duly reflected in an increased steam yield. If the CO were allowed to remain and return to the chambers, temperature conditions would be favourable at certain times to the reaction $2CO \rightarrow CO_2 + C$, which would cause an unsightly blackening of the coke, and has been the cause, in some systems, of complaints of objectionable fine dust production.

Cost of Gas Production in Intermittent Vertical Chambers.

At the 2nd Bituminous Coal Conference, Dr. E. W. Smith presented a valuable study of comparative costs of gas manufacture by various methods, including vertical chambers. Since that time certain changes have occurred in the relative value of the products of carbonization which render those figures subject to correction, and in Table I. the costs have been re-assessed where it seemed necessary.

As is well known, the cost of gas into holders is greatly influenced by the cost of coal at site and by the price obtainable for coke, while the price of tar has now a much smaller influence than three years ago. The conditions selected for Table I. have been chosen in an attempt to show a fair comparison between the different systems under present conditions while departing as little as possible from the data assumed by Dr. Smith. Thus, in the case of continuous vertical retorts, the figures are identical with those in his table save for the altered value of tar. The table demonstrates that the cheapest gas can be made in intermittent vertical chambers, and still more cheaply with those adapted for coke dry cooling.

Steaming in Intermittent Vertical Chambers.

Efficiencies up to 70 p.ct. are common in vertical chamber oven practice owing to the great depth of glowing coke through which the steam must pass. On the other hand, it is doubtful if more than 35 p.ct. of the steam admitted is decomposed in continuous vertical retorts. Such undecomposed steam represents a double loss, first by virtue of the heat removed by it from the retort, and secondly owing to the extra heat consumption at the ammonia recovery plant in distilling the diluted liquor made. Steaming is controlled by time rather than by volume in vertical chambers, there being an optimum rate of admission for a given wall temperature. Accurate adjustment of the steaming rate is secured by the insertion of an orifice plate between the regulating valve and distributing chamber which exists in each door frame. In the C.O.L. system the base-plate casting is hollow, and thus provides a steam space along each side of the door frame. Downwardly directed orifices deliver the steam into the oven immediately above the door, and the convex dome of the latter serves to effect even distribution of the steam via the breeze pad to the overlying coke. Since the steam passes up through about 20 ft. of glowing coke the water gas production occurs at high efficiency and the calorific value exceeds 300 as a rule. In one test after one hour's steaming the calorific value was 320, but this high figure was probably due to the fact that some residual volatile matter (mainly hydrogen) was still being evolved by the coke and contributing to the water gas production. J. S. Thorman recently made some valuable tests on steaming for different periods and at different rates of operating the chamber plant. An interesting series of curves were plotted showing the progress of water gas production, and variations of calorific value, flue temperatures, &c., during steaming. It is of interest to calculate from Thorman's data the consumption of coke per 1000 c.ft. of water gas made for comparison with external water gas plant figures:

Total Coke Consumption for B.W.G. Production in I.V. Chambers.

Steaming Period.	C.V. of Water Gas Assumed.	Total Coke Consumed in Producers and Chambers per 1000 C.Ft. B.W.G.
		Lbs.
2 hours	300	27·7
3 ,, ...	290	26·83
6 ,, ...	290	28·06

The above figures are considerably better than those usual in external water gas plant, and are due to the following reasons: (1) Ordinary water gas plant is non-recuperative, whereas intermittent vertical chambers are heated recuperatively. Thus the coke consumed in the "blow" cycles of a water gas plant is higher than the corresponding fuel consumption at the producers serving a vertical chamber installation during steaming. (2) Coke used in external water gas plant has to be heated up from cold, whereas in intermittent vertical chambers it is already at a high temperature before water gas production is begun. This factor is considerably less important than (1). It is clear that from the aspect of carbon balance water gas is more economically produced in vertical chambers than in external generators, and full recognition of this fact may conceivably lead to developments in the use of such chambers for special purposes. Thus it is feasible that intermittent chambers may provide a useful means for the total gasification of coal in exceptional cases where it is desired to restrict the production of coke. It will at least be of some value to a gas engineer to know that in case of special emergency—*e.g.*, during coal shortage, he could use a vertical chamber installation in this way.

Total Gasification via Intermittent Vertical Chambers.

In the event of vertical chambers being used for the total gasification of coal it is quite likely that the unique possibility of segregating the water gas from that produced by carbonization will be utilized. At certain synthetic ammonia works the hydrogen is obtained from water gas by catalytic oxidation of carbon monoxide to carbon dioxide and absorption under pressure of the total CO_2 in water. At present the water gas is made indirectly from coal by the use of an installation of coke ovens followed by a battery of external water gas generators gasifying the coke from the ovens. Total gasification of coal in intermittent vertical chambers, and segregation of the water gas, would enable the latter to be made direct in a single plant.

Factory Illumination in Relation to Safety

Synopsis of Address delivered by Mr. J. S. Dow, Hon. Secretary to the Illuminating Engineering Society, at a Meeting of the Industrial Section of the London "Safety First" Council on Jan. 11

Good lighting in the factory comes *first* among hygienic requirements because it is obviously indispensable. No work can go on in a factory unless people can *see*—and no one can see without light. Adequate lighting is essential on both humanitarian and economic grounds. But considerations dictated by humanity are usually equally valid from the economic side. Everyone admits the need of taking every possible precaution to prevent employees suffering death or injury as the result of accidents; but such precautions are also good policy because of the loss that accidents invariably entail.

This loss consists of two portions—(1) the direct loss against which it is usually possible to insure, and (2) various incidental and indirect losses which cannot be insured against. Every accident leads to subsequent disorganization of factory processes in some degree—especially if injury is involved. But many accidents, not to employees, but to plant and material, may also be of great importance, and may easily be caused by inadequate lighting conditions. Even if the entire loss to the manufacturer can be met by insurance, the loss involved in this spoilage is still a loss—and there are other considerations, such as loss in prestige, trouble caused to third parties by failure to deliver goods to time, &c., which it is difficult to estimate.

Mr. R. E. Simpson, in a paper before the American Illuminating Engineering Society, has expressed the view that roughly 15 p.ct. of industrial accidents in the United States (which occasion an annual loss of nearly £400,000,000) are attributable to inadequate lighting. He also quotes an instructive example of an accident due to inadequate lighting, which led to incidental and uninsurable losses of £6000.

All this serves to show that it is false to grudge the cost of furnishing adequate illumination in factories. This

expense is almost invariably only a small percentage—sometimes less than 1 p.ct.—of the total cost of production.

Insufficient or wrongly directed light, dazzle, or misleading shadows are all liable to cause accidents both to workers and material. Shadows are specially liable to cause accidents in the form of " persons falling " in certain trades; it has been shown that these and some other forms of accidents are seasonal—*i.e.*, the accident-rate is greatest in the short winter months, when artificial light is mainly used.

Conditions of lighting that give rise to danger, almost always also result in poor work. Thus a dim and feeble illumination, when it is a source of danger, leads to a feeling of apprehension and hesitation which inevitably slows down production, whereas ample illumination results in a feeling of confidence.

A considerable amount of research into the influence of intensity of illumination on production has taken place, specially noteworthy being the investigations conducted by the Illumination Research Committee, on the effect of illumination on fine processes (typesetting by hand). In this case it was shown that full efficiency was only attained with illuminations of the order of 20 to 25 foot-candles (comparable with good daylight illumination in interiors), and the principle doubtless applies broadly to fine processes. It should not be assumed, however, that better lighting automatically ensures higher production in any factory, and it is perhaps inexpedient to present the principle in this form; it is better to say that good lighting removes drawbacks that handicap the worker and makes it possible for him to put forth his best efforts.

In the concluding portion of the address examples of typical modern industrial lighting installations were presented, and it was explained how the fundamental requirements of good lighting—(1) sufficient illumination, (2) absence of glare, (3) elimination of troublesome shadows, and (4) steadiness of light—may be met. Of special importance are the use of white coloured paints and distempers for walls and ceilings, so as to diffusely reflect the light, and the provision of a proper maintenance scheme to ensure lamps and fittings being kept in good condition. Each industry presents special problems, and instances of trades in which special conditions (such as the use of artificial daylight) are necessary are dealt with.

Costing in Relation to the Manufacture of Gas

By Major R. N. Barnett, T.D., A.S.A.A., Chief Accountant to the South Metropolitan Gas Company.

[A Paper before the Southern Association of Gas Engineers and Managers (Eastern District), Dec. 16, 1931]

Budgetary Control.

It is essential to my mind that all undertakings, whether they be gas or otherwise, should exercise budgetary control over expenditure in conjunction with their costing system. As the architect or the engineer plans his structure in advance and then proceeds to erect the work in accordance with the prearranged plan, so should the items of the revenue account be planned in advance, the actual figures being compared with the estimates week by week or month by month as they become available. The captain of a vessel does not sail from port with just a hope that the weather will be fine and the sea calm. Not only does he know his destination and date of arrival, but he takes his bearings day by day to ascertain if he is in advance of or behind his schedule; yet many business firms enter a new financial year with just a hope that expenses will be lower, that sales will be better, and that a fair profit will accrue at the end of the year. In these days of keen competition it must follow that the undertaking which carefully estimates and plans its expenses and revenue in advance and compares the actual figures with the estimates week by week or month by month as the year progresses is the one which will eventually survive the stresses of financial depression and competition. It is true that sales may not realize as much as anticipated or that unforeseen expenses may occur, but if costs are kept completely under control a warning of any variation from the standard which has been set will be given at the earliest moment, and adequate steps can be taken to rectify matters.

In a gas undertaking the manufacture of gas in the revenue account is divided into the following headings—Coal, Wages, Purification, Salaries, Repairs and Maintenance. With the exception of Coal, Repairs and Maintenance is usually the heaviest item, and it is here that budgetary control and subsequent costing can be of great use. In preparing the estimates a certain amount would be allocated to Repairs and Maintenance. A portion of this amount would be allotted to each gas-making station, and a portion would be reserved for sundry items which may not be chargeable to any particular station. The amount allotted to a station would, in the first place, be divided into three main headings:

1. General Repairs and Maintenance of the Works.
2. Repairs and Renewals of Retort Settings.
3. Special work to be carried out during the year.

These three headings would each be divided into further sub-headings according to a prearranged cost code, and the expenditure of each of these would be recorded week by week so that a careful check would be kept on expenditure as compared with the estimate, and any over-expenditure immediately noted.

General Repairs and Maintenance would be an allowance to cover every expense of a general running nature, and for the purpose of estimates could be taken at a fixed amount per week or month, it being more or less recognized that this item is constant. Where, however, an unlooked-for breakdown causing heavy expenditure happens, for purpose of comparison the item should be kept isolated in the costing system, so that variation of this nature could be pointed out if the actual expense for the period differed greatly from the estimates.

Repairs and Renewals of Settings and special work would be dealt with in a different manner, and as we know that these jobs would be carried out in the summer season, allowance should be made in the budget for increased expenditure during this period. Of course, the engineer might not execute his work in accordance with his schedule. This, however, would show up in the costs and could be explained accordingly.

Cost Code.

It will be realized that the first essential of a costing system is an adequate cost code by means of which every item of expenditure would be given a cost number. A cost number with two parts is in my estimation most desirable for gas undertakings, the first consisting of a section cost number which would apply to each branch of expenditure, and the second a sub-cost number which would be used for sub-dividing the cost number into further headings of expenditure. Thus the first item in the revenue account—namely, coal—might be given the cost number of, say, 1, coal purchases having the cost number 1 and a sub-cost number 1—coal unloading, cost number 2, 2/1 being process cost of unloading, 2/2 haulage of coal from point of unloading. Carbonizing wages would be given cost number 3, 3/1 producer firemen, and so on for all items of revenue or expenditure.

This system would provide for 999 cost numbers, each of which could have, if desired, 999 sub-cost numbers, thus there could be in all 1,000,000 cost numbers in the code, if required.

The indirect charges, such as steam, compressed air, internal railway charges, &c., could have special cost numbers. These costs would be divided between the plants in ratios which are from time to time agreed between the accounting and technical staffs, and the proportions debited against the cost numbers applicable. Having printed and circulated the cost code, the whole of the expenditure in respect of wages and materials could be allocated to particular cost numbers and the necessary returns readily compiled. The staff using the cost code from day to day could readily memorize the cost numbers with which they would be particularly concerned.

The method of collating costs which I am going to describe is the punched card system whereby holes would be punched on cards to represent the required information. The card would consist of columns of figures of 0 to 9, there being 45 columns across the card. The columns would be divided so that each column represented some information which would be desired for recording purposes; then instead of writing the desired figure on the card the particular number would be punched out of the card. These cards would be sorted and tabulated and the results printed by machinery. I would, however, point out that the information could be compiled without machines, but that their use would permit centralized costing and speed of results which are not otherwise possible.

It is therefore easy to visualize the necessity for the con-

version of all information required to be collated into numerical equivalents. The works, if there were more than one, would be given code numbers which would be used on all cards punched for that works. The date is also numerically arranged, so that Dec. 16, 1931, would be punched either as the 50 week or as 16·12. No doubt every firm of any magnitude knows its employees by number, and so Bill Jones, as in the Army, becomes known on the punched card as 1234.

Cost Ledgers.

A separate cost ledger would be kept for each station, a page being appropriated to each section and sub-section number. The dates of the week would be printed on the left-hand side of the sheet and totals made monthly. Thus the expenditure at any station on any cost number could be immediately ascertained. The information required for entering up the cost ledger would be obtained from the following sources, which I shall describe:

1. Wages analysis tabulation.
2. Wages transfers.
3. Direct purchases.
4. Issues from store.
5. Material transfers.

Columns would be provided in the cost ledger for cost per decatherm, which could be inserted where desired.

Wages.

A record of each man's time and wages would be made on a card termed the Master Analysis Card; there would be spaces for the man's name, occupation, rate of pay, and man number. The number of hours spent each day on each job would be recorded on the card, the cost number of the job being inserted, and the gross wages paid to that man divided according to the number of hours spent on each job. There would also be a place on the card for the code number of the gas-making station, and the day and the month of the year. These cards would be completed at the gas-making stations, a differently arranged card being used if a man is a coke loader, a coal unloader, or employed on piece work. The information required for these cards would be obtained by means of daily time sheets, weekly time sheets in the case of permanent shift men, log books for yard workers who work directly under control of a ganger who is held responsible for piece work notes; all piece work would be recorded on these notes, different forms being used in the case of coal or coke which are on a tonnage basis to those on charging oxide boxes, machine shop piece work, &c. These piece work notes would serve a dual purpose, inasmuch as they would be authorization to the wages clerk to pay the men, as well as a record of work for cost office use.

In the case of carbonizing men—that is, men at work in the retort house—a daily time sheet is unnecessary, as their Master Analysis Card can be entered from the time book in total, provided it is not desired to make any division of retort house costs such as the costing of sections of a retort house, in which event it would be necessary to have a daily time analysis for each carbonizing man. If the Master Analysis Cards are calculated by the cost office staff and then agreed with the amounts shown in the wages sheets against such man's name before the wages are paid, any mistakes of the cost clerk would be rectified and an independent check on wages is afforded.

Having agreed the total of these Master Cards with the wages sheets, the cards would be forwarded to the central cost office. Here they would be handed to young girls to punch a wages analysis card with the man number, date, works, code number, and the amount applicable to that code number, a separate card being punched for each code number. The card could be divided into two parts, one-half of the card being used at a time; this would economize in the number of cards used. There would be two machines used in this process, a punch and a verifier. The verifier would not punch holes, but would release only when there is a hole in the position required. The girls punch these cards at the rate of 300 per hour, and as they are punched they are passed to another girl, who verifies.

As soon as a station's cards have been punched and checked they would be passed through the tabulating machine, which accumulates the amounts which have been punched on these wages analysis cards, the machine doing this at a speed of 150 per minute; the total as shown by the machine should agree with the total amount of wages paid. Running through this operation, even in the case of a large works where wages cards have been punched to the extent of thousands, only takes a few minutes. If the total of the wages, as represented by the holes on the cards which the machine prints, does not agree with the total of the wages paid as supplied by the gas-making station, the method of finding the error is very simple. The whole of the wages analysis cards for the particular station are put through the sorting machine and sorted to man numbers, the sorter doing this on one column at the rate of 400 per minute. The tabulating machine is then employed to add all cards bearing the same man number together and print the totals of each man on a sheet. The Master Cards are called over with this list and the error should be discovered at once.

The cards would then be passed through the sorting machine, and those which have indirect numbers would be first extracted, sorted into order, and tabulated, the totals being divided into the proportions already agreed upon, fresh cards being punched for the cost numbers which are to be debited. These cards would be placed with the remainder of the punched cards in lieu of the cards with indirect numbers which have been extracted. The whole of the cards, which would be in no particular order, would then be put through the sorting machine which arranges them in consecutive order; thus all cards with the cost number 1/1 would come first, followed by those with 1/2, 1/3, and so on for the remaining cards. The machine sorts one column at a time, and the operator works from units upwards. Having sorted the cards, they would be placed in a tabulator, which may be plugged so as to record totals and print any of the information which has been recorded on the cards in any order which may be desired. The whole of the information on the cards can be printed, but it is usual to take off the minimum required, as this tends to speed the machine. The tabulator is so controlled to print the cost number, sub-section number, and the amount debited to each, the total at the end of the tabulation naturally agreeing with the total wages paid.

From this tabulation an "Analysis of Wages Sheet" is collated. The cost is grouped into the main headings of Process, Repairs and Maintenance, Miscellaneous Items, and items not applicable to gas-making. On the left of the sheet is the cost number, then a description of the items of expenditure, the expenditure for the week, and the expenditure for the previous week, the increase or decrease in money on the previous week being shown. Above each week's expenditure is shown the therms made. The cost per decatherm of the current week and the previous week would be worked out and inserted; the number of tons handled and the cost per ton for the current week and the previous week would be worked out and inserted; the number of tons handled and the cost per ton for the current week and the previous week, where tonnage is applicable, are also included.

If the wages week ends on Thursday morning, wages could be paid on Friday, and some of the statements would be in the hands of the engineers before the men have been completely paid. In any case they could all be completed by the following Monday. By means of this return an engineer is enabled, each week-end, to ascertain how his wages have been expended, and any irregularities that have occurred during the wages week.

As carbonizing wages is the heaviest item of wages, a further analysis would be made dividing the expenditure into some 32 headings. This again would be calculated to show the cost per 100 therms made and per ton of coal carbonized, and would be in the hands of the engineers each Monday for the week ended the previous Thursday. Here again we have a very good indication as to the expenditure on carbonizing wages.

A comprehensive comparative Carbonizing Return would be compiled to show the cost per 100 therms and per ton of coal carbonized, and the average of all stations for the present and the past year. The costs are grouped under definite headings in order to supply the technical staff with information in a pre-arranged form. This form is of exceptional use, inasmuch as it enables everyone concerned to distinguish rises and falls in carbonizing process cost and the works at which gas is being most economically produced.

The wages tabulation would be entered in the cost ledgers and also in Total Company Wages Analysis Book in summarized form to agree with the Revenue Account headings, this book being used for final account purposes.

The wages punched cards would then be available for any further information required, and I would suggest that in the case of machine shops, &c., code numbers could be given to each shop and each man's Master Card marked with this number. In this way the cards could be sorted to shop number, the indirect charges or non-productive labour extracted—*i.e.*, general shop work, repairs to machines, foremen, &c.—and each group of cards bearing the same shop number run through the tabulator for total amount of wages paid in respect of productive labour in each shop. It would then be an easy matter to ascertain the shops' overhead charges and compare prices with outside quotations, effect economies in the administration of the shops, and, in all, be in a position to substantiate the running of them as an economical proposition.

Wages Transfers.

Work done by one station for another gas-making station would be shown on the Master Analysis Cards under

the special cost number for wages transfers. The central cost office making out a debit note against the station for which the service was rendered, giving full details, and this would be forwarded to the engineer concerned, who would certify it as being correct, and would insert the cost numbers which should receive the debit for this work. Upon the return of this form to the central cost office, wages transfers would be credited and the particular job would be debited.

Materials.

All purchases of materials could be dealt with in one of two ways; where the purchase could be debited to a particular plant direct, for instance, in the case of purchase of machinery, this could be done. If it is an article of general store it could first be debited to the stores suspense account, and upon issue it would be credited to the store adjustment of the plugs on the tabulating machine.

(*a*) *Purchases.*—The weekly accounts for payment would show the cost number which is to be debited. Each account upon payment would be carefully scrutinized by the central cost office to ensure that no error in appropriation had been made. The analysis of these accounts would be done by means of the punched cards, a purchase analysis card being punched for each cost number on the invoice. The card would be designed to record the following information: The bill number, the transaction, the day and month, whether debit or credit, station, cost number, works order number, and amount of money. When verified the cards would be first run through the tabulator to ascertain whether the total agrees with the accounts passed for payment. They would then be sorted so that the cards would be in consecutive cost number order, and put through the tabulating machines which prints the total under each cost number. If additional information should be required to be printed, such as the bill number or the works order number, it could be done by adjustment of the plugs on the tabulating machine.

The tabulation of the purchases would be posted to the cost ledger for costing purposes, and an abbreviation of it entered in the materials purchase books for final account purposes in the same manner as wages.

(*b*) *Issues from Stores.*—The total of the purchases which go into store would be debited against a stores suspense account. Once a week each station's storekeeper would forward to the cost office his orders for issues from stores, on which would be recorded all materials which have been drawn from store; no materials being issued from store without a signed order form. They would be priced, and the calculations extended before they are sent away from the stores. The central cost office would punch cards from these issue notes. The cards would record the following information: Transaction, station, day of week and month, debit or credit, cost number, works order number, and amount. These cards would be sorted and tabulated to cost number. The amount of each cost number would be entered in the cost ledger under the heading of Material *ex* Stock Account, and the stores suspense account would be credited with the total. The balance of the stores suspense account should at any time equal the value of goods in stock at stations, and this would naturally be checked at stations by means of periodic stock-taking.

Material Transfers.

Material transfers would be effected by forwarding a material transfer invoice to the receiving station. The receiving station would certify it, at the same time inserting the cost number which is to be debited. The central cost office, on receipt of the certified and appropriated material transfer form, would make the necessary entry in the cost ledger.

I have referred to the necessity of comparing the actual cost with the estimates throughout the year, especially in regard to Repairs and Maintenance of Works. From the recording which I have described it would be possible to compile all the returns which the management or station engineers might reasonably require.

The management would be supplied with returns showing briefly what is happening throughout the undertaking as a whole, the figures being mainly in total form, whereas the station engineer would require more detailed returns showing the amount applicable to his particular station, and how that amount had been expended, whether in wages, purchases, material *ex* stock, &c. The figures used for the management and the station engineers would be those which would eventually form part of the final accounts of the company; the central cost office therefore should keep in closest touch with the chief accountant's office—it may, in fact, be deemed a part of it.

A weekly statement of Repairs and Maintenance showing the amount authorized for the year, the amount authorized to date on a weekly basis, the total amount spent to date, and whether a station is over or under spent, could be prepared for the management within three days of the close of each week.

This statement would have the advantage of simplicity, and could be used as a general guide, but it would not show the true position where heavy expenditure took place which would not be equally divided over the year. The return would be true as regards general repairs and maintenance, but not with regard to repair and renewal of settings, which would be done during the summer months, nor with regard to special jobs which may be done at any time.

If each engineer could inform the accountant how much he anticipates spending of his authorized amount each week, the return could be adjusted accordingly. It would, however, be difficult for the engineer of a large station to do this for a year in advance.

A more comprehensive return can be prepared weekly for each station which would show:

1. The total allotted for the year divided over the various plants.
2. The total amount expended on each plant up to the date of the last return.
3. The amount expended on each plant during the week in respect of Wages, Wages Transfers, Purchases, Petty Cash, Materials *ex* Stock, and Material Transfers.
4. The total expended for the week.

The cumulative total expended to date would be carried to the return for the subsequent week.

The last column would draw attention to any items which may be overspent when compared with the estimate. Each engineer should receive this statement within six days of the close of his wages week. The total of the wages expended on repairs and maintenance in this return should naturally agree with the amount shown on the analysis of wages form.

As all stations would be using the same cost code, the details of the expenditure incurred by them could be compared. A statement of the amount expended by each station under each sub-cost number of General Repairs and Maintenance could be compiled, and would be worked out to show each station's cost per decatherm and per ton. It would be found that there are great differences when the sub-cost number expenditure of one station is compared with that of another.

Periodic meetings of the cost clerks of all stations should be held by the central cost office, and the reason for the differences inquired into. By this means it is probable that economies could be effected. It would be advisable to have a representative of the engineering staff present at the meeting to take a note of those matters which are brought to light in the discussion, which would be items for the management to attend to as apart from accounting matters.

The centralization of costing would at once make possible the use of the most up-to-date office machinery, which would not only be available for costing, but could be used for any other department of a company which had work to be done, but which work would not justify the cost of a complete installation of machinery or the employment of additional staff. It would permit the compilation of innumerable comparative returns which might, from time to time, be desired by the management. It would also ensure that any figures which were supplied had a direct relation to the figures which form the final accounts of the company, indeed in most cases they form a part of them; but in addition to the foregoing advantages it will be found that once the system is established it can conveniently undertake additional work. As an example, I will cite the matter of compilation of the return of wage earners for income-tax purposes.

The method which appears to be adopted by most companies is for a clerk to enter from the wages sheet on to cards or sheets the amount of wages paid week by week to each wage earner, this being done as soon as the payment of wages is completed. At the end of each half-year the weekly amounts paid to each man are totalled, and the total of each card or sheet is written up in the Inland Revenue Book known as H.9, which shows the name, number, amount of wages, &c., in respect of each man. The first part of this work is usually done by juniors, and it is doubtful if the total wages paid is always agreed with the total wages for each man which is returned to the inspector. You will realize that having the amount of the gross wages for each man on the Master Analysis Card it is only necessary to punch the pay number and the amount of wages on each card week by week, and at the end of 26 weeks to sort these cards to man number and put them through the tabulating machine, which prints the man number and the total amount of wages as recorded on the 26 cards. Certain additional information, such as name of man, &c., may be typed on the sheets after they have left the tabulator, and they can then be forwarded to the Inland Revenue Authorities, who, by special arrangement, will accept them in lieu of the H.9 book which would otherwise have to be written up by hand.

Causes, Effects, and Remedies of Atmospheric Pollution

By T. M. Ashford, Senior Smoke Inspector, Public Health Department, Glasgow.

[From an Address to the Scottish Junior Gas Association. Joint Meeting on Jan. 9]

It has generally been accepted from investigations made in the various parts of the country that domestic smoke is responsible for 70 p.ct. of the total pollution present. Smoke is produced in far greater quantity per ton of coal burned in domestic fires than in industrial furnaces. In the former about 5 to 6 p.ct. of the coal burned is emitted from the chimney in the form of smoke, while in the latter the smoke is probably only 2 or 3 p.ct. of the fuel. The domestic grate or range does not permit of such complete combustion as the boiler furnace, one result of which is that the larger percentage of tar appears in the domestic soot, amounting to between 20 and 40 p.ct. of its total weight. This tar gives the soot adhesive properties, by which it is enabled to stick to the leaves of plants and the surfaces of buildings, &c., in spite of the washing by rain.

Emission of Sulphur Compounds.

In spite of the small percentage of sulphur contained in fuel, it contributes the most injurious constituent of smoke. This sulphur is emitted in the form of sulphur dioxide or trioxide and sometimes as hydrogen sulphide, but whatever be the form in which it is emitted it rapidly oxidizes into the trioxide, which, combining with the atmospheric moisture, forms sulphuric acid.

To get some idea of the great quantity of impurities poured into the air, the results of a few investigations and calculations made by the two eminent authorities on the smoke problem—namely, Messrs. Shaw and Owens—may be given. It may be taken as roughly accurate that with 1 p.ct. of sulphur in coal 50 lbs. of sulphuric acid are produced per ton of coal consumed. In the British Isles, exclusive of Ireland, about 40,000,000 tons of coal are burned for domestic purposes annually, and if we assume that this coal has at least 1 p.ct. of sulphur, which is probably a low estimate, it will produce each year 900,000 tons of sulphuric acid. This acid comes down with the rain to poison the soil in the neighbourhood of our cities and to destroy the fabric of our buildings. When we add to this figure the 100,000,000 odd tons used for industrial purposes and calculated on the same basis, this would produce about 2,000,000 tons of sulphuric acid. Thus in the aggregate we have something like 3,000,000 tons of sulphuric acid poured into the air over these Islands per year.

The sulphuric acid is not necessarily kept out of the atmosphere if visible smoke is prevented, but the smoke particles have the power of absorbing the acid and thus concentrating it wherever the smoke may settle. According to the same authorities, the amount of soot which is ejected from our chimneys per year may be taken as approximately 2,500,000 tons. Some of this settles in the neighbourhood of its source, while much of it is carried by the wind over the whole country. As part of this soot it may be taken that there are about 500,000 tons of tar.

Solid Smokeless Fuels.

If the present types of domestic grates with their undoubted advantages are to be retained and smoke avoided, the chief hope lies in the use of a smokeless solid fuel, and the only fuels of this kind available are ordinary gas coke, low-temperature coke, and anthracite. In the case of the latter the fire generally requires to be closed, as with this type of fuel, being so inert, it is necessary to conserve by every means possible the draught at our disposal. It is very economical, does not require lighting afresh each day, but may be kept burning, with the result that the house is dry and warm night and day throughout the whole winter. It requires very little attention and produces much less dust than do the open fires. Owing to the fact that the heating is chiefly by convection rather than radiation, the air of the room is liable to get very warm and dry. Also, with this type of appliance the ventilation produced is most unsatisfactory, and it is necessary to look to ventilation of the apartment by other means. This question of ventilation when using these stoves is particularly important, because, owing to the reduced air supply, carbon monoxide is very liable to be produced, and of course as this is highly poisonous, hence the reason for adequate ventilation.

The use of anthracite would do away with smoke, but it cannot be looked to for a solution since there is not sufficient anthracite available. The total quantity produced is round about 4,000,000 tons, whereas the amount of coal consumed, as already stated, for domestic purposes is round about 40,000,000 tons. It is evident, therefore, that there is not enough to meet the possible requirements.

Most of the advantages obtained with the use of the open grate are also to be obtained when either of the cokes are made use of, particularly that carbonized at low temperature. Indeed, from tests that have been made in various parts of the country, the percentage of the heat of the fuel is actually greater when low-temperature coke is used than with coal, the difference in favour of this fuel being about 10 p.ct.

Much has been written in the Technical Press regarding the merits or demerits of this type of fuel, and there has been much divergence of opinion as to the suitability of the fuel for both domestic and industrial use, but I am strongly of the opinion that a fuel of this type will be one of the ultimate solutions of the smoke problem. The principal recommendation of this product as a solid fuel is that the volatile content is appreciably higher than that contained in the ordinary high-temperature coke, varying as it does from, say, 4 to 8 p.ct. This ensures that the fuel is more easily kindled, or, in other words, is not so inert, and does not require the same intense draught, two factors which will prejudice the housewife in favour of fuels of this type.

Ordinary high-temperature gas coke is sold for domestic purposes in open competition with coal. Preference for coke in most cases is due not merely to its smokeless characteristics, but also to its inherent efficiency and economy as compared with raw coal. The Fuel Research Board have pointed out that coke gives more radiant heat than coal of a higher calorific value. Reports on comparative tests made by Dr. Margaret Fishenden, of the Fuel Research Board, prove the radiation efficiency of ordinary gas coke burning in open firegrates to be 24 to 28·5 p.ct., as compared with 21 to 24·5 p.ct. for best quality house coal. The use of gas coke for domestic purposes is certainly becoming more general, in spite of the inherent difficulty in lighting, although it can be easily lit when done carefully. Many new types of firegrates suitable for the burning of ordinary coke have been placed on the market recently.

Real Economy of Gas.

On cost alone gas is the cheapest fuel for all intermittent employment. If, however, factors having economical value other than fuel cost are taken into consideration, as they should be, gas can be demonstrated to be the cheapest fuel for both intermittent and constant use for almost all purposes. These factors, in the case of the domestic consumer of gas, are a considerable saving in the wear, tear, and cleaning of the house and its contents, the elimination of labour and storage, and the reduction in the expenditure of the nervous energy of members of the household and the staff by reason of these considerations and the fact that the service is immediately available when required.

The domestic uses of gas are more apparent than the industrial, since with over 90 p.ct. of the population cooking by it there must be very few who are not conversant with its utility. It is satisfactory to think that the problem of cooking without smoke has not only been solved, but put into effect by the Gas Industry. Unfortunately the problem of smokeless domestic heating is not completely solved, largely owing to that innate prejudice in favour of the open fire. Many people, remembering the old-fashioned, unsightly gas fire which heated too much by convection and was very often badly fitted, have to be convinced that the modern gas fire has the hygienic and æsthetic properties of the traditional coal fire. In point of fact the modern gas fire is an artistically designed and healthy open fire, giving out radiant heat, aiding ventilation, capable of instant regulation, entirely free from smoke, and performing its task more efficiently and economically (if allowance is made for expense additional to the solid fuel cost) than would raw coal, electricity, or even coke.

Coke for Steam Raising.

Coke is now used extensively as fuel for steam raising in hand-fired boilers of all descriptions. With ordinary natural chimney draught the usual rate of firing is from 8 to 18 lbs. per square foot of firegrate per hour, according to the draught available. Higher rates up to 25 lbs. are usual with forced draught furnaces. Generally speaking,

fires from 6 to 9 in. in thickness should be maintained according to the draught available and the size of coke used. The draught should be reduced to the minimum necessary to maintain the required output of steam. No secondary air over the fire is required for coke. All air admitted to the furnace should pass through the fire bars.

Gas coke of good quality, say 12,000 B.Th.U. per lb., gives fairly high evaporative factors, as high as 9 to 10 lbs. of water per lb. of coal being achieved. The efficiency of combustion varies from about 60 p.ct. to more than 80 p.ct., according to the conditions of use, and with coke it is possible to maintain a high CO_2 percentage in the spent gases. Forced draught furnaces improve the efficiency and maintain the full normal evaporative capacity of the boilers with coke exclusively as fuel. Forced draught coke-burning mechanical stokers, particularly of the chain grate type, can maintain the full normal output with coke breeze exclusively as fuel in many cases at 80 p.ct. overall efficiencies. The Sandwich system of burning cheap coal slack and coke breeze in superimposed layers to prevent the formation of smoke has for many years been used successfully in several of the most important and efficient electric power stations.

Discussion.

Mr. DAVID GARRIE (President of the Eastern District), who presided, reminded those present that the paper had been written from the general point of view of smoke abatement.

Mr. A. MCDONALD (President, Western District) said they had learned a lot from the paper of the nature and causes of pollution effects. If they were more generally known he thought the public would press for legislation in the way of smoke abatement, but they would have to be educated to the deleterious effects of atmospheric pollution—that was a duty for the Smoke Abatement Society, who were to be congratulated on the work they were carrying out.

Mr. MUNRO (Edinburgh) remarked that the fuel problem was one which the average individual looked at from the point of view of price. It was a question of educating the public to appreciate the value of a clean atmosphere and its contribution to health.

Mr. J. RICHMOND (Penicuik) said that if they could do anything to improve the health of the nation through smoke abatement then it certainly would be beneficial, but it seemed to him that on this matter of health there were different notions. Some went to the length of saying we were degenerating into a C 3 nation. We had more hospitals, and there was the fact that the police could not get the standard of men they got formerly, and even the military authorities had reduced their standard. He was therefore doubtful if all the hygienic improvements had gone to benefit the race in general.

Mr. ASHFORD, in reply, suggested that the reason we have more hospitals is that we are treating people for diseases which we did not years ago, and the reason for the reduced standards in the police is that we do not need them now. "I think most will admit to-day that we are of better physique—certainly our girls are. There is not nearly so much trouble from rickets now as even 20 years ago—better housing, feeding, and higher standards of living doubtless being the principal reasons for the advance made."

Water Softening Plants

By J. C. COTTERILL, of Worcester.

[From a Paper before the Midland Junior Gas Association, Birmingham, Jan. 14]

This will be an account of the working of the several types of plant for dealing with hardness of water which the writer has been able to operate and study.

It is important that feed water treatment should embody some method of ridding the water of dissolved gases.

It is the custom in boiler practice to blow out of the boiler, at certain definite periods, a quantity of water, with the object of removing as great a proportion of the dissolved, and now concentrated, solids as possible. Water softening desires to remove as many of these constituents as possible by precipitation methods before the water arrives at the boiler, the remaining solids being of such a composition that no scale formation will take place.

"Hardness" is divided into two classes—"temporary" and "permanent." Temporary hardness consists of bicarbonates of calcium and magnesium, and may be completely removed by boiling the water.

$$Ca(HCO_3)_2 = \underset{\text{ppt.}}{CaCO_3} + CO_2 + H_2O$$

Permanent hardness consists of the mineral acid salts of calcium and magnesium, and is usually removed by treatment in a suitable plant with lime and soda ash.

In average practice both temporary and permanent hardness are removed by similar chemical treatment.

$$CaMg(HCO_3)_2 + Ca(OH)_2 = CaMg\,CO_3 + CaCO_3 + 2H_2O$$

$$CaMg\begin{Bmatrix}(NO_3)_2\\Cl_2\\SO_4\end{Bmatrix} + Na_2CO_3 = CaMg\,CO_3 + \begin{Bmatrix}2\,NaNO_3\\2\,NaCl\\Na_2SO_4\end{Bmatrix}$$

The calcium and magnesium carbonates are precipitated and removed by suitable filters, and the remaining constituents, more or less innocuous, pass on to the boiler, whence they are removed by "blowing down."

Another well-known method of softening water is by the unique property possessed by Permutit or Zeolite, which is a complex mixture of the silicates of sodium and aluminium. The sodium may be wholly replaced by the calcium or magnesium of the raw water, softening the water completely with a minimum of trouble.

$$Na_2Al_2Si_2O_8 + CaCO_3 = CaAl_2Si_2O_8 + Na_2CO_3$$

The sodium may then be replaced in the Zeolite by regeneration with brine and the softening process continued as before.

$$CaAl_2Si_2O_8 + 2NaCl = Na_2Al_2Si_2O_8 + CaCl_2$$

This cycle of reactions takes place absolutely indefinitely with no apparent change in the physical structure of the zeolite.

The various types of plant which the writer has been able to study will now be considered in the light of the foregoing facts with investigation of working results.

The operation of the latest development in water softening plants, the continuous blowdown system, will also be considered.

WATERS AVAILABLE.

The water for boiler feed purposes was available from three sources: (*a*) Town supply, (*b*) a well sunk on the works into which the water percolated through a bed of clay and marl, giving a flow of about 1000 gallons per hour, and (*c*) a brook running past the works, having its source in a lake and consisting mainly of surface water, which gave an almost unlimited supply.

The town water supply was at once ruled out owing to the cost. The sole cost of either of the other waters was pumping charges. This was a consideration, as the well supply was of a constant hardness and in a central situation on the works, while the brook, though of a lower hardness, varied considerably in hardness with the rainfall (necessitating a high degree of refinement in the softening plant) and was at a considerable distance from the boilers.

The boiler plant on the works consisted at this time, 1923, of two Lancashire boilers, one being kept as a standby.

From the point of view of accessibility for cleaning purposes, this type of boiler did not necessitate softening to any fine degree as was the case with the firetube waste-heat boiler installed in 1926, to which reference will be made later on.

The softening plant installed was a lime-soda plant, fitted with a tipping bucket arrangement which delivered to the raw water a definite proportion of a mixture of lime and soda ash, previously prepared from the analysis of the water.

The calculated quantities were:

	Well.		Brook.	
Lime	3·5	..	2·25	Lbs. per 1000 galls.
Soda	3·5	..	2·5	

This was so nearly a 50/50 mixture that it was considered sufficiently accurate to make up one mixture and use varying quantities of it for the different waters.

The mixture was slaked every three days in a semi-cylindrical tank with sufficient water to make a milk, and was kept of an even consistency throughout the period by a stirring arrangement which was operated by the motion of the tipping buckets.

Any variation in the inlet hardness, with a corresponding variation in the outlet hardness, was compensated for by

the adjustment of a "chemical valve," through which the mixture was admitted to the plant, thus increasing or decreasing the quantity of lime-soda mixture added to the water. The water leaving the reaction chambers was filtered through two wood wool filters and passed into the boiler free from all save a small percentage of suspended solid matter, depending largely on the state of cleanliness of the plant.

On opening up the boiler after six months' work, there was found to be a scale of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. thickness, consisting chiefly of calcium and magnesium carbonates. On putting the boiler to work again in an endeavour to minimize scale formation, a certain vegetable compound, of tannin origin with some sugar and probably caustic soda, was added to the softened water, the object being to maintain all sludge formed in the boiler in a flocculent state. This would prevent settlement as scale and enable all sludge to be removed in the blowdown water. The amount of compound added was 1 pint per 1500 gallons of feed water. Further trouble with heavy scale formation led to the increase of this compound to 1 pint per 1000 gallons of water.

About this time, 1925, the load on the boiler increased, owing to the installation of additional plant on the works. The supply of water from the well, also, began to be seriously diminished owing to subterranean causes. Frequent recourse to the brook supply became necessary. This, though of a lower hardness, varied considerably with rainfall, as stated, introducing a factor to which the existing softening plant was unable to respond. It was obvious that this was to be the works water supply in the future.

Also, at this time, the installation of the firetube waste heat boiler was imminent, and the compact arrangement of the heating tubes made efficient cleaning between them almost impossible. Thus a fine degree of softening was essential; this was unattainable with the existing softening plant.

Installation of New Plant.

Of the various designs submitted, the one that seemed likely to prove the most satisfactory was a combination of a lime soda plant, reducing hardness to 2-3 degrees, followed by a natural zeolite plant, reducing hardness at inlet to boiler to zero. The existing lime-soda plant was not retained owing to the inability to vary the amounts of lime and soda individually as required, a feature possessed by the proposed new plant.

A complete study was then made of the variations in the composition and hardness of the raw water with a view to determining fully the advantages and costs of the proposed new method.

Plants Installed.

Lime Soda.—The existing plant was used with a few modifications. The tipping bucket gear was removed and its place taken by a small head tank feeding into a revolving distributor. The lime saturator and soda solutioner were placed alongside. The end chamber of the plant, previously a small storage tank, was converted into a final filter for the water passing to the zeolite plant.

An arrangement of nozzles screwed into pipes connected to the raw water supply, was concreted in the bottom of the tank, covered with 6 in. of $\frac{1}{2}$-in. Rowley rag, 6 in. of $\frac{1}{4}$-in. quartz, and 2 ft. 6 in. of fine clean sand, passing through $\frac{1}{8}$ in. mesh and retained on 1-32 in. mesh.

By this means the sand was backwashed for removal of $CaCO_3$ precipitate carried forward beyond the wood wool filters.

The water leaving the revolving distributor was divided into 5 streams, 3 main ones entering the reaction chamber, one being taken to the lime saturator and the other to the soda solutioner. The lime was slaked in an overhead tank and washed into the bottom of a large cylindrical container.

Sufficient lime was added to give a fairly constant strength throughout the 24 hours and the amount passing into the softener was varied by the adjustment of a slide in the distributor chamber which allowed more or less water to flow to the lime saturator. The lime passes to the plant as "lime water" and not in the form of a milk.

The soda was made into a cake with a minimum quantity of water, broken into pieces rather less than 1 in. cube, and placed, as required, into a perforated basket in the solutioner. The amount of soda-ash passing to the plant was varied by adjustment of the strength of the solution, the depth of immersion of the basket being altered by raising or lowering the weir.

It is seen, therefore, that the lime and soda are added separately.

Zeolite Plant.—The water leaving the lime soda plant passed to the zeolite plant. The natural zeolite was contained in a vertical cylinder, the water entering at the top, passing downwards through the zeolite to the bottom, the outlet pipes being arranged to keep a 2 ft. seal on the bottom of the cylinder.

The brine tank was placed alongside and connected by a suitable arrangement of pipes and valves, a steam ejector being utilized to force the brine through the zeolite. The cylinder contained sufficient zeolite to replace 70,000 grains of $CaCO_3$ before requiring revivification. The volume occupied by the zeolite was approximately 40 c.ft. With an average daily throughput of 7500 gallons the time of contact of water with zeolite is about 45 minutes.

Attention Necessary—Labour.

Lime Soda Plant: Daily.

1. Agitation of wood wool filters by steam injectors and running off of the $CaCO_3$ and $MgCO_3$ driven to the surface.
2. Agitation of sand filter with raw water and removal of similar precipitates.
3. Running off sludge from base of lime saturator. This consists partly of unused lime (an excess always being added) and partly of precipitate from reaction with the raw water.
4. Preparation of soda—*i.e.*, forming into cake. Plant cleaned out every 3 months. This consists of drawing off all water; cleaning out all precipitate; pricking up wood wool, washing with hose pipe and replacing; thorough backwashing of small filter. Replacement of wood wool and sand by fresh material every two years.

Zeolite Plant.

1. Revivification when required, dependent on load on plant and hardness of water leaving lime-soda plant.

Process of revivification consists in: Injecting brine into plant then, after about 15 minutes contact has been allowed, backwashing until free from all traces of chloride. Preparation of fresh brine may be done while backwashing is in progress.

Technical Attention Necessary.

1. Hardness of inlet and outlet water.
2. Methyl orange and phenolphthalein alkalinity tests and causticity test of outlet water.
3. Tests of strengths of lime and soda solutions.

A complete record should be kept of all these tests and of all adjustments made to the plant.

Practical Difficulties Experienced.

Lime Soda Plant.

1. Lime strength not constant. Occasionally reduced practically to *nil*.

Traced to (*a*) lime not having been properly added to saturator. (*b*) During heavy load was found to be due to utilizing water from nearby condensers at about 180° Fahr.

2. Soda strength not constant.
3. Imperfect softening owing to incomplete precipitation of magnesium compounds.

These cannot be completely precipitated in the cold. Winter temperature at the plant averaged 40-45° Fahr.

The difficulty was eventually surmounted by passing waste steam from the exhausters in a pipe passing longitudinally through the raw feed water pipe, the water filling the annular space around. By this method an increase of temperature of 35-40° Fahr. was obtained. This increase was fairly constant throughout the year, as the quantity of waste steam available increased with the increase of load on the softening plant.

4. Skin of sand filter must be kept covered or air-locks occur in outlet pipe.
5. During daily backwashing of this filter it becomes filled with raw water which passes on untreated to zeolite plant.

As the time approaches for cleaning out the plant this disadvantage becomes more pronounced. Owing to wood wool and sand filters being choked, both with $CaCO_3$ and deposit from muddy water, the backpressure thrown necessitates more frequent backwashing of filter to preserve an adequate supply. This may result in as much as 50 p.ct. of the total daily load being raw water.

Precautions in Working Zeolite Plant.

1. Plant must be as nearly as possible freed from salt before allowing water to pass to boiler. Serious corrosion on feed water pipes and automatic shutoff balls in water level gauge glasses has been traced to this cause.

The test prescribed by the makers of the plant, of tasting the water to ascertain freedom, is not sufficiently delicate; the concentration of chloride remaining in feed water may be as much as 1000 grs. per gallon. This becomes 320,000 grs. per gallon in the blowoff water. An intelligent attendant can easily be instructed to perform a test for presence of chloride by the addition of $AgNO_3$ solution, a bottle of which, of strength 0·15 p.ct. approximately, may

be kept by the plant. Even with this method, the average concentration in the blowdown water was found to be 400 grains per gallon.

2. "Packing" of zeolite may occur. In this event there is a great temptation, on the part of those responsible for working the plant, to open the by-pass valve sufficiently to keep an adequate supply of water flowing to the feed tank.

Trouble with back pressure may be easily overcome by removing the manlid at the top and loosening material with a bar. This should be done periodically to ensure a free flow of water.

3. Possibly the most objectionable feature of zero hardness water is its absorptive affinity for O_2, being much more pronounced than with raw water.

This is aggravated by allowing water to cascade from the plant into storage tank; the outlet pipe should always be immersed well below the surface of the water.

Many undesirable features are therefore seen to be presented by this method of treating boiler feed water, introducing corrosion, excess scaling, and expense.

The method of the intermittent blowdown of the boiler also introduces two main sources of loss.

1. The softening materials produced by interaction of the dissolved solids in the boiler are blown to waste.

In the waste heat boiler at Redditch, attempts were made to keep the concentration of NaOH at 60 grs. per gallon. Occasionally blowing down twice or even three times per shift was necessary to attain this figure.

Approximately 75 gallons of water are blown down each time.

At a concentration of 60 grs. per gallon and blowing down three times a day:

$$\text{Total NaOH} = 60 \times 225 = 13{,}500 \text{ grs.}$$

$$\underset{80}{2NaOH} + \underset{162}{Ca(HCO_3)_2} = Na_2CO_3 + CaCO_3 + 2H_2O$$

80 grs. NaOH will treat 162 grs. Ca $(HCO_3)_2$.
Then 13,500 grs. will treat 27,330 grs. $Ca(HCO_3)_2$.
This is contained in approximately 2000 gallons of water or 26·6 p.ct. of daily throughput.

By blowing down approximately four times the quantity at present, sufficient softening material would be provided to eliminate the use and purchase of lime.

2. By the intermittent blowdown the heat units are lost.

225 gallons blowdown at temperature of 310° Fahr. Temperature of inlet water 60° Fahr.
Heat available for transfer to inlet water

$$= 2250 \times 250 = 562{,}500 \text{ B.Th.U.}$$

By blowing down boiler four times as proposed:

$$\text{Heat available} = 562{,}500 \times 4 = 2{,}250{,}000 \text{ B.Th.U.}$$

It is almost impossible to store this water so that both its chemical and heating properties would be available, so the intermittent blowdown is being superseded by the continuous blowdown system, the most modern and economical system of water softening yet devised.

Operation of Continuous Blowdown System.

1. Determine a safe concentration of dissolved solids in the boiler; keep to this within small limits.
2. By a special cock, the sludge is continually removed and returned to the softening plant.
3. Discharge a small proportion of the water to waste continuously for removal of silicate scale, the amount removed thus depending on the silicate content of the raw water.
4. Make up the deficiency of softening material in blowdown water by the addition of the required amount of soda ash solution only.

The reaction tank consists of a vertical cylinder with a conical base in which the precipitated sludge, formed by the reactions in the plant, is collected. The soda ash required per day is dissolved in a small tank situated at ground level for ease of operation, and the solution is ejected through a strainer into a feed tank fixed on a platform at the top of the reaction tank. The flow of soda into the softener is regulated by the adjustment of a valve on the underside of the tank to such a speed that the tank is emptied in 24 hours. It is then sludged off and replenished.

By the use of softened water for dissolving the soda, wastage by sludge formation is reduced to a minimum.

The sludge returned from the boilers passes through a tee above the plant, and is divided into two streams. One goes direct into the water, acting both as a softening and heating agent, while the other, about 20 p.ct. of the total blowdown, goes through a closed coil of pipe in the softener and is discharged as waste for silica removal. The heat only of this portion is utilized.

The crude water passes into the softener through a float regulated valve and discharges from the pipe below the surface of the liquid, meeting the discharges of soda solution, and returned sludge.

In this way the maximum contact of crude water with softening material is ensured.

Any available exhaust steam should also be brought to the plant to ensure the softener working at as high a temperature as possible; 160° Fahr. should be aimed at and maintained if possible.

The temporary hardness is largely removed by the heat, the softening material in the blowdown accounting for nearly all the remainder. The ebullition and temperature ensure the complete removal of O_2, this being a feature possessed by no other softening plant.

The blowdown fittings on the boiler consist of the usual large blowdown valve, with its connections to the usual settling tanks. This is for use only on occasions when the softening plant is shut down. Prior to this, the continuous sludge return pipe is taken off, of much smaller diameter (usually ¾ in.), and on this, in an easily accessible position, is placed the special regulating cock, which also embodies a test cock.

The regulating cock should be opened fully once per day to flush the system free from possible deposits, and set again to the required mark. This should be performed by the technical assistant.

The only other technical attention necessary is a daily titration of the sample of blowdown water withdrawn from the test cock, to ensure keeping within the specified limits, and the calculation of the amount of soda to be added for the following 24 hours.

The labour necessary daily is: Sludging off soda feed tank, dissolving fresh soda and ejecting into feed tank, and sludging off conical base of softener. The latter may with advantage be done every shift.

The plant is cleaned out every three months.

These advantages, therefore, are obtained:

1. Softening materials of blowdown water recovered.
2. Heat of blowdown water recovered.
3. Concentration of dissolved solids in the boiler is under control.
4. Efficient softening ensured.
5. Elimination of boiler corrosion.
6. Complete removal of dissolved O_2 of feed water.
7. Reduction in technical attention, labour charges, and softening materials used.

That these advantages are borne out to the fullest extent in practice is the experience of those who have installed this type of plant.

Appendix.—*Costs of Softening Processes.*

Based on a consumption of 2,800,000 galls. of water per annum.

Total hardness	28 degrees
Permanent hardness	12 ,,
Temporary lime	16 ,,
Permanent magnesia	7·5 ,,

Depreciation in all plants may be reckoned approximately the same.

1.—Lime-Soda Mixture.

Material—	£	s.	d.
1 cwt. per 9500 galls. of water equals 14 tons 15 cwt. per annum at £10 10s. 6d. per ton	155	5	0
Cost of tannin compound not available.			
Labour—			
1 hour every three days equals 122 hours at 1s. 2d.	6	14	0
Cleaning plant out every three months, three men for 10 hours, equals 120 hours at 1s. 2d.	7	0	0
Total	£168	19	0

Cost per 1000 galls equals 14·48d.

2.—Lime-Soda and Zeolite Plants.

Material—	£	s.	d.
1·8 lbs. soda ash per 1000 galls. equals 2 tons 5 cwt. at £7 3s. per ton	16	1	9
1·88 lbs. lime per 1000 galls. equals 2 tons 7 cwt. at £3 6s. 7d. per ton	7	16	6
36 lbs. of broad salt per regeneration. Allowing total hardness at inlet of zeolite plant of 6·5 degs., there are 260 regenerations per annum. Salt equals 4 tons 4 cwt. at £2 14s. 2d. per ton	11	7	1
Wood wool, 5 cwt. every two years at 15s per cwt.	1	17	6
Sand, 15 cwt. every two years at £3 per ton	1	2	5
	£38	5	3
Labour—	£	s.	d.
Lime-soda plant ½ hour daily equals 182½ hours at 1s. 2d.	10	12	11
Preparing soda, 1 hour per week equals 52 hours at 1s. 2d.	3	0	10
Cleaning out plant, as above	7	0	0
Zeolite plant, 260 regenerations of ¾ hour each equals 195 hours at 1s. 2d.	11	7	6
	32	1	3
Total	£70	6	0

Cost per 1000 galls. equals 6·03d.

3.—Continuous Blowdown System.

	£	s.	d.
Soda, as for 2	16	1	9
Labour, as for 2	10	12	11
Cleaning plant out, as for 2	7	0	0
Replacement of wood wool, as for 2	1	17	6
Total	£35	12	2

Cost per 1000 galls. equals 3·05d.

Discussion.

The President (Mr. W. L. S. Spinks) congratulated the author upon his contribution. He asked if the zeolite was a natural, or a manufactured, product, and, if the former, whether it was always of a uniform standard.

Mr. W. MacNaughton (Wolverhampton), in proposing a vote of thanks to Mr. Cotterill, said that he had made out a case for the continuous blowdown system. They had, he said, a similar plant at Wolverhampton, which was working satisfactorily, although he had experienced difficulty in pumping water at a temperature of 150° to 160° Fahr.

Mr. P. Millington (Birmingham), in seconding, pointed out that he had had no experience with the continuous blowdown system, but the zeolite plant at the Nechells Works had worked very well. With a zeolite plant one had to keep the alkalinity constant and as low as possible. It was of the utmost importance that a constant watch should be kept upon the inlet water, as any variation which was not noted meant that the chemical plant would show a wrong working. He had not found that zeolite threw any back pressure, and in the plant to which he referred it had been in use about six years.

Mr. Cotterill, in reply to questions, said that zeolite occurred naturally and was also manufactured, the artificial material being somewhat larger than the natural and not having the same length of life. He agreed as to the necessity of carrying out tests of inlet water, as one could never guarantee that the natural hardness would remain constant. With the continuous blowdown system no scale was formed, and if there were scale on the boilers it was gradually removed.

British Sulphate of Ammonia Federation, Ltd.

Annual Report for 1930-31

The following extracts are from the Eleventh Annual Report of the Federation for the year ended June 30, 1931:

World's Production and Consumption of Fixed Nitrogen.

During the year under review it is estimated that there was a decrease of 509,252 metric tons of nitrogen, or about 23 p.ct., in the actual production of the forms of nitrogen enumerated below. The production in Chile decreased by 214,000 tons, or about 46 p.ct., and output in other countries decreased by 295,252 tons. The total nitrogen producing capacity in the world at the present time is estimated to be about 3,000,000 tons of nitrogen, exclusive of Chile.

The total consumption decreased by 329,492 tons, or 17 p.ct., following on increases for the years 1927-28, 1928-29, and 1929-30 of 25 p.ct., 14 p.ct., and 4 p.ct. respectively.

The following figures are offered as fair estimates, but strict accuracy is not claimed for them:

World Production and Consumption of Pure Nitrogen for the Fertilizer Years

[In Metric Tons.]

—	1928-29.	1929-30.	1930-31.
Production—			
Sulphate of ammonia—			
Bye-product	376,000	424,440	359,594
Synthetic	485,000	442,100	349,087
	861,000	866,540	708,681
Cyanamide	210,000	263,800	200,932
Nitrate of lime	136,000	130,500	110,585
Other forms of nitrogen*—			
Synthetic	365,000	427,300	393,150
Bye-product	51,000	51,400	30,940
Chile nitrate	490,000	464,000	250,000
Total production	2,113,000	2,203,540	1,694,288
Consumption—			
Manufactured nitrogen	1,452,630	1,586,904	1,377,005
Chile nitrate	419,450	363,893	244,300
Total consumption	1,872,080	1,950,797	1,621,305
Agricultural consumption about	1,684,000	1,750,000	1,455,000

* Including ammonia products used for industrial purposes and ammonia in mixed fertilizers.

Note.—Fertilizers are included in these tables under the final form as sold, so that, for example, cyanamide if converted into sulphate of ammonia is included under synthetic sulphate of ammonia, or, if into ammophos, is included under other synthetic nitrogen.

During the past year the economic position of agriculture has deteriorated still further, and the decreased purchasing power of farmers has been reflected in the decline in consumption of fertilizers. The fall has with few exceptions affected every form of nitrogen, whether for fertilizer or for industrial use, in every continent. The biggest reductions in tonnage consumed have been in U.S.A., Germany, Holland, France, and Poland, and the largest percentual decline in Cuba. The greatest increase in tonnage was in Russia, and as a percentage, in Portugal. But whereas the world consumption of Chile nitrate has declined by 33 p.ct., the demand for bye-product and synthetic nitrogen has fallen off by only 13¼ p.ct.

The Convention de l'Industrie de l'Azote (C.I.A.), the European nitrogen cartel, had a beneficial effect, in bringing world production in 1930-31 more nearly into line with consumption, instead of being enormously in excess as in the two previous fertilizer years. A further large increase in stocks was thus avoided; but even further action was necessary if the surplus stocks which had been built up were to be reduced. Strenuous efforts were made throughout the year under review to find a permanent basis for co-operation among the nitrogen producers of the world. But during the final negotiations which continued throughout June and July, 1931, and at which the Federation was represented by Mr. H. Smith, it unfortunately proved impossible to reconcile the claims to shares in the trade put forward by the various groups, notwithstanding the heavy sacrifices which the British and German synthetic groups had declared their readiness to make.

Since July, therefore, the nitrogen market has been the playground of unrestricted competition. Most European countries which are both producers and consumers have adopted protection in one form or another and maintained a level of prices slightly lower than that of last season. In the free markets a fall in price of the order of 50 p.ct. has taken place. In normal circumstances, such a fall would have greatly stimulated sales, but in the present world-wide crisis no very marked effect can be hoped for. In view of the financial strength of the groups concerned, the important part which nitrogen plays in military calculations, and the apparently general acceptance of the fashionable ideal of high protection, it would appear idle to expect an early termination to the struggle which is now in progress.

Home Production.

The figures in the following table showing the total production of ammonia products, expressed as sulphate, are calculated on the basis of 25 p.ct. ammonia (about 20·6 p.ct. nitrogen). The figures for sulphate of ammonia production and trade, however, apply to actual tons of product with a nitrogen content of about 21 p.ct.

Production of Ammonia Products and Output of and Trade in Ammonium Sulphate in Great Britain and Ireland and Channel Islands.

[Tons of 2240 lbs.]

Calendar Year.	Total Production of Ammonia Products, Expressed as Sulphate of Ammonia Equivalent (Basis 25 P.Ct. Ammonia).				Included in the Total.	
	England and Wales.	Scotland.	Ireland.	Total Great Britain and Ireland.	Industrial Ammonia Products (Basis 25 P.Ct. Ammonia)*	Sulphate of Ammonia as such (Actual Tons of Product).
1928.	566,001	74,907	3928*	644,836	63,258	564,180
1929.	865,698	73,929	3910*	943,537	70,520	840,396
1930.	730,508	69,895	3557*	803,960	85,843	677,263

* Estimated.

Home Agricultural Consumption.

Home consumption of sulphate of ammonia showed a decline on the 1929-30 figures of 21,740 tons, or 11·85 p.ct. As shown in the table below, foreign imports amounted to 3085 tons. The total consumption of pure nitrogen in the United Kingdom for all purposes amounted to about 60,760 metric tons, against 67,924 tons last year. The tonnage used in industry is estimated at 17,400 tons, against 20,400 tons last year.

The detailed figures for sulphate of ammonia are on p. 209.

The total consumption of Chile nitrate is estimated at 54,500 tons, as against 56,000 tons for last season.

Exports.

Total exports from Great Britain and Ireland show a decrease of 177,938 tons, or about 28 p.ct., on last year's figures, but

Great Britain and Ireland and Channel Islands.

[Tons of 2240 lbs.]

Fertilizer Year.	Total Production of Sulphate of Ammonia as such.	Agricultural Consumption of Sulphate of Ammonia in—				Agricultural Consumption of Chile Nitrate (*).	Sulphate of Ammonia.	
		England, Wales, and Channel Islands.	Scotland.	Ireland.	Total British Isles and Channel Islands.		Exports from—	Imports into—
							Great Britain and Ireland other than to or from the Channel Islands.	
1928–29	645,042	108,736	47,072	30,902	186,710	49,500	428,437	384
1929–30	865,878	108,441	40,592	34,483	183,516	48,000	634,405	3,556
1930–31	545,972	96,270	36,387	29,119	161,776	47,500	456,467	3,085

(*) Estimated.

—	1928-29.	1929-30.	1930-31.
Spain, Portugal, Canaries	104,396	221,380	166,519
Japan	146,087	158,971	52,062
China and Hong Kong.	93,332	109,888	72,206
West Indies, British Guiana, and Mauritius	17,919	16,263	16,101
India and Ceylon	30,808	37,312	21,150
Australia and New Zealand	5,220	20,083	15,151

during the year there has been a considerable reduction in the stocks in hand.

The figures in the opposite column show the shipments to the principal markets.

MEMBERSHIP.

At June 30, 1931, the Federation consisted of 245 members, and their production for the calendar year 1930 was 98 p.ct. of all the sulphate of ammonia manufactured in this country. During the past two years 107 members of the Federation have ceased production.

Shanklin Gas Company and the Ventnor Undertaking.

On Friday, Jan. 22, at the Town Hall, Ventnor, Mr. J. F. Ronca, Director of Gas Administration to the Board of Trade, conducted an inquiry concerning the application of the Shanklin Gas Company for a Special Order for the acquisition of the gas undertaking of the Ventnor Gas and Water Company. Two objections to one of the clauses in the proposed Order had been lodged—one on behalf of the Isle of Wight County Council and the other on behalf of the Ventnor District Council. Mr. S. Cope Morgan presented the case for the Shanklin Company, and among others present were Messrs. E. D. Davey and Arthur Morland (Accountants), the Engineer, Manager, and Secretary (Mr. F. C. Taylor), and several Directors of the Shanklin Gas Company, Mr. V. G. Middleton (Chairman of Directors of the Ventnor Gas and Water Company), the Clerk and Chairman of the Ventnor District Council and several members, and Mr. John Dufton (Clerk to the County Council).

Mr. COPE MORGAN, after remarking that the opposition to the Order was practically on one point only, said that there were three important factors to be taken into consideration with the idea of efficiency in supply and economy of administration. The first point was the situation of the gas-works at Ventnor, which could scarcely be worse. On the other hand, the Shanklin Works could not be more favourably placed. The next point was the question of the area of supply. The Ventnor area was very small, and therefore the opportunity of expansion by the Ventnor Company was small as compared with Shanklin. The third point was the equipment of the two Companies. The works at Ventnor could not accommodate modern carbonizing plant, and therefore economy was impossible. On the other hand, the Shanklin Company had an equipment which was very up-to-date. The speaker said that recent additions and improvements at the Shanklin Works had been installed especially to supply the demands of Ventnor, and went on to outline the events leading up to the amalgamation of the Shanklin and Ventnor Companies. The objection to the Order was not on a point of broad policy, but on the price of the differential rate of the cost of gas necessarily put on Ventnor for the years immediately ahead. Touching this point, the speaker put in a statement prepared by Mr. Morland. One point was in regard to the excessive capitalization of the Ventnor Company. The statement showed an output for 1930 of 299,000 therms by the Shanklin Company, against 135,000 by that at Ventnor. The percentage of output for Ventnor was 45·15 of that of Shanklin, and the capital of the respective Companies was: Shanklin, £50,000, and Ventnor, £28,000. Continuing, the speaker referred to the existing differential rates imposed by the Shanklin Company as between what were known as the inner and outer areas. In the inner area, which was 6 furlongs from the works, the maximum standard price was 18·6d., in the outer area 19·8d., and in the Ventnor area the figure proposed was 23·4d. The actual charges being made to-day were: Shanklin 1s., outer district 1s. 1½d., and Ventnor 1s. 6d. Under the Order what was immediately contemplated was: Shanklin, no change, 1s.; outer area, a reduction to 1s. 1d.; Ventnor, an immediate reduction from 1s. 6d. to 1s. 4d.; after five years another reduction to 1s. 3d., and after another five years a reduction to 1s. 2d. After 15 years the price at Ventnor would become the same as that charged in the outer area.

It might be a wise gesture for the Ventnor Council to lodge a protest, but there could be no substance in it at all. The Company would have greater possibilities of expansion, of supplying better and cheaper gas at an improved pressure, and generally the whole scheme was one which must of necessity make for economy, to the advantage of all concerned; on these grounds he venture to commend the Order. The objection spoke of the proposed price as "unwarranted," and contended that the price charged to the Ventnor consumers should "at once" be the same as that charged in the outer area. There was no word of gratitude for the fact that Ventnor was immediately to have a reduction of 2d. in the price of gas, and he ventured to say that the words "unwarranted" and "at once" were quite unreasonable. Why should Ventnor at once be charged the same? Why should Shanklin consumers shoulder the burden of giving to Ventnor consumers a first-class, well-sited, up-to-date gas-works instead of an antiquate ill-sited works which could not be reasonably developed? It was a scheme which had no fundamental objection.

Mr. *A. Morland* gave evidence in support of the application, and various questions were put by the Clerks to the Ventnor Council and County Council.

Register of Patents

Naphthalene and Moisture Removal. No. 356,763.

CLAPHAM, T. A., of Keighley.

No. 13,628; May 3, 1930.

This invention relates to the treating of coal gas in order to remove or extract therefrom naphthalene and moisture. It consists in a method and apparatus wherein the gas passes through a series of heat-exchanging chambers, first being cooled by indirect contact with gas that has already passed through the chambers, and, secondly, cooling by indirect contact with cold liquid, the gas being brought into contact with a solvent oil throughout the treatment.

Gas Heating Systems.—No. 356,892.

JAMES KEITH & BLACKMAN COMPANY, LTD., and KEITH, G., both of London.

No. 23,073; July 31, 1930.

This invention relates to gas heating systems for gas-fired bread and biscuit ovens and like apparatus. It provides an improved arrangement enabling large quantities of gas to be burned in a combustion chamber without necessity to spread the combustion over a distance in small units of flames, being designed for heating by circulation of hot products of combustion. A system according to the invention comprises sets of burners surrounded by a tube extending within a combustion chamber, connections for supplying separately gas and air to each set of burners, means for controlling separately the supply of gas and air, a governor for controlling the supply of gas, through separate branches, to the sets of burners to maintain a constant proportion between the gas and the air, draught means for removing the products of combustion, and means for varying the draught to regulate the flow of gas and air to the burners. In the particular case described one of the sets of burners comprises a single central burner, and the other set comprises a group of burners surrounding the central burner.

GAS MARKETS & MANUFACTURES

Stock Market Report.

[For Stock and Share List, see later page.]

Under the influence of Continental speculation business on the Stock Exchange last week was irregular, though in the absence of any serious liquidation prices, with few exceptions, moved within narrow limits. Home investors continued to confine their attentions to the gilt-edged group and other well-secured fixed-interest-bearing securities, industrials for the most part being left severely alone. The Government's announcement with regard to the Cabinet and tariffs was was well received in the city, and this, together with a prospect of some reduction in the Bank Rate in the near future, should give a fillip to business.

Gas stocks and shares were again in good demand and, with few exceptions, prices showed a tendency to harden, particularly debenture issues, some of which more than regained the recent *ex* div. reductions. Among ordinary stocks to show improvement, Plymouth and Stonehouse 5 p.ct. recorded the substantial increase of 7 points to 116½, while Alliance and Dublin and European gained 2 and 3 points respectively.

The first of the dividend announcements for the past half-year are now coming to hand, and among these last week were those of two out of the three big Metropolitan Companies—viz., the South Metropolitan and Commercial. The former Company is recommending a final dividend on the ordinary stock of 3½ p.ct. (against 3¾ p.ct.), making 6 p.ct. for the year, as compared with 6¼ p.ct. for 1930, and the Commercial Company has announced a dividend for the December half-year of 2⅞ p.ct. (against 3 p.ct.), making 5⅞ p.ct. for 1931 (against 6 p.ct. for 1930). The small reductions in each case slightly affected prices, and the Commercial stock dropped 1 point to 92½ and the South Metropolitan stock 1½ points to 97. Both these Companies are seeking further capital powers, and extraordinary meetings will be held next month (the South Metropolitan on Feb. 10 and the Commercial on the following day) at which the proprietors will be asked to approve the Bills for this purpose now pending in Parliament.

A further addition has been made this week to the Stock and Share List by the inclusion of the Bournemouth Gas and Water Company's 5 p.ct. irredeemable debenture stock. The amount of this stock outstanding is £210,000, and interest is payable on Jan. 1 and July 1. The official quotation on Saturday last was 92-97.

Current Sales of Gas Products.

The London Market for Tar and Tar Products.

LONDON, *Jan.* 25.

There is little change in the values of tar products.

Pitch is firm at 85s. per ton f.o.b.

Creosote, for export, varies from 3¾d. to 5d. per gallon f.o.b., according to specification.

Pure toluole is about 2s. 8d. to 2s. 9d. per gallon at makers' works; pure benzole is 1s. 8d. to 1s. 9d. per gallon; 95/160 solvent naphtha is about 1s. 5d. per gallon; and 90/140 pyridine bases, about 3s. 9d. to 4s. per gallon.

Tar Products in the Provinces.

Jan. 25.

The average prices of gas-works products during the week were: Gas-works tar, 27s. to 31s. Pitch—East Coast, 60s. to 65s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 60s. to 65s. f.o.b.* Toluole, naked, North, 1s. 10½d. to 1s. 11d. Coal-tar crude naphtha, in bulk, North, 5d. to 5¼d. Solvent naphtha, naked, North, 1s. 3d. to 1s. 3½d. Heavy naphtha, North, 11d. to 11½d. Creosote, *ex* works, in bulk, North, liquid and salty, 3½d. to 3¾d.; low gravity, 1¼d.; Scotland, 3½d. to 3¾d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid, 60's, 1s. 7¼d. to 1s. 8d. Naphthalene, £9 to £10. Salts, 55s. to 75s. bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Jan.* 23.

Refined tar for road making is now being offered more freely, and values appear to have settled at to-day's level. Other products show little or no alteration.

Pitch.—Production continues low, and export value remains nominal at 65s. to 70s. per ton f.o.b. Glasgow. In the home market, about 75s. per ton is now being quoted for truck loads at makers' works in bulk.

Refined tar to Ministry of Transport Specification is steadier; the prices for both prompt and forward delivery being 4d. to 4½d. per gallon f.o.r. works in buyers' packages.

Creosote oil.—Market remains steady with supplies on the short side. B.E.S.A. Specification is 3d. to 3¼d. per gallon; low gravity, 3½d. to 3¾d. per gallon; and neutral oil, 3½d. to 3¾d. per gallon; all f.o.r. in bulk.

Cresylic.—There is a lack of interest in this product and, supplies being plentiful, prices are easy. Pale, 97/99 p.ct., 1s. 2d. to 1s. 3d. per gallon; dark, 97/99 p.ct., 1s. 1d. to 1s. 2d. per gallon; and pale, 99/100 p.ct., 1s. 4d. to 1s. 4½d. per gallon; all in buyers' packages *ex* works.

Crude naphtha.—Available supplies command about 4½d. to 5d. per gallon f.o.r., according to quality.

Solvent naphtha.—There being very little business passing prices are nominal at 1s. 3d. to 1s. 4d. per gallon for 90/160 quality, and 1s. to 1s. 1d. per gallon for 90/190 quality.

Motor benzole remains quiet, with quotations at from 1s. 3d. to 1s. 4d. per gallon in bulk quantities *ex* works.

Pyridines.—90/160 grade is 3s. to 3s. 3d. per gallon, and 90/140 grade 3s. 3d. to 3s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole	0	7	to	0	7½	per gallon at works
Motor ,,	1	2	,,	1	3	,, ,, ,,
Pure ,,	1	6	,,	1	7	,, ,, ,,

Contracts Advertised To-Day.

Electric Wiring.

The Oldham Corporation Gas-Works Committee invite tenders for the electric wiring of power plant. [Advert. on p. 214.]

Gasholder and Foundations.

The Barry Urban District Council invite tenders for the construction and erection of a gasholder and foundations. [Advert. on p. 213.]

General Stores.

The Works and Ways Committee of the Nottingham Corporation invite tenders for the supply of general stores, &c. [Advert. on p. 213.]

Picks, Shovels, &c.

The Works and Ways Committee of the Nottingham Corporation invite tenders for picks, shovels, &c. [Advert. on p. 213.]

Pipes and Specials.

The Gas and Water Department of the Clacton Urban District Council invite tenders for the supply of cast-iron pipes and specials. [Advert. on p. 213.]

Pumping Plant.

The Oldham Corporation Gas-Works Committee invite tenders for sewage lifting and pumping plant. [Advert. on p. 214.]

Retorts.

The Loughborough Gas Committee invite tenders for the renewal of retorts. [Advert. on p. 213.]

Tar and Pitch.

The Slough Gas and Coke Company invite tenders for their surplus tar. [Advert. on p. 214.]

The Works and Ways Committee of the Nottingham Corporation invite tenders for the supply of pitch and refined tar. [Advert. on p. 213.]

Metropolitan Gas Companies' Testings.

The Gas Referee's report on the official testings for the past quarter gives the following average calorific values for the gas supplied by the Metropolitan Companies named.

Commercial Gas Company.—504 B.Th.U. (declared calorific value, 500 B.Th.U.).

Gas Light and Coke Company.—502·1 B.Th.U. (declared calorific value, 500 B.Th.U.).

South Metropolitan Gas Company.—561·6 B.Th.U. (declared calorific value, 560 B.Th.U.).

South Suburban Gas Company.—562·4 B.Th.U. (declared calorific value, 560 B.Th.U.).

Tottenham and District Gas Company.—502·6 B.Th.U. (declared calorific value, 500 B.Th.U.).

Wandsworth and District Gas Company.—501·7 B.Th.U. (declared calorific value, 500 B.Th.U.).

STOCK AND SHARE LIST.

Official Quotations on the London and Provincial Stock Exchanges.

[For Stock Market Report, see earlier pages.]

Issue.	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr.	Dividends. Last Hf. Yr.	NAME.	Quotations. Jan. 23. (Provincial Exchanges Jan. 22.)	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
£			% p.a.	% p.a.				
1,551,868	Stk.	Oct. 5	7⅞	7⅞	Alliance & Dublin Ord. ...	102—107	+2	104⅛—105
374,000	,,	Jan. 4	4	4	Do. 4 p.c. Deb. ...	65—70*	...	...
522,655	,,	Aug. 24	7	7	Barnet Ord. 7 p.c.	120—125	...	124—125
300,000	1	Oct. 19	1/93	1/4⅛	Bombay, Ltd.	15/—17/6	...	16/1½—16/3
174,500	10	Aug. 10	9	9	Bournemouth 5 p.c. ...	14⅜—15⅜	...	...
500,050	10	,,	7	7	Do. B 7 p.c. ...	12—13	...	12½—12⅝
439,160	10	,,	6	6	Do. Pref. 6 p.c. ...	10½—11½	...	...
50,000	Stk.	Dec. 14	3	3	Do. 3 p.c. Deb. ...	53—58	...	...
162,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	73—78	...	...
210,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	92—97	...	...
357,900	,,	Aug. 24	7½	7½	Brighton & Hove 6 p.c. Con.	114—119	...	...
371,880	,,	,,	6⅝	6⅝	Do. 5 p.c. Con.	104—107	...	...
1,287,500	,,	July 23	5	5	Bristol 5 p.c. max.	88—90a	...	...
120,420	,,	Jan. 4	4	4	Do. 1st 4 p.c. Deb. ...	77—79a	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	77—79a	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	97—98a	...	...
855,000	,,	Oct. 5	8	7	British Ord.	108—113	...	110½
100,000	,,	Jan. 4	7	7	Do. 7 p.c. Pref.	108—113	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	69—74	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	90—95	...	...
160,000	,,	Jan. 4	5	5	Cambridge 5 p.c. Deb. ...	90—95	...	...
100,000	10	Nov. 30	8	6	Cape Town, Ltd.	8½—9½	...	...
100,000	10	Oct. 30	4½	4½	Do. 4½ p.c. Pref. ...	6¾—7¼	...	...
150,000	Stk.	Jan. 4	4½	4½	Do. 4½ p.c. Deb. ...	65—70	...	69½—70
696,860	,,	July 23	6	6	Cardiff Con. Ord.	95—98	...	...
237,860	,,	Jan. 4	2⅜	5	Do. 5 p.c. Red. Deb.	91—96	+3	...
157,150	,,	Aug. 10	6½	5	Chester 5 p.c. Ord.	87—92b	...	...
98,936	1	Oct. 5	†2/-	2/-	Colombo, Ltd. Ord....	27/—32/-	...	...
24,500	1	,,	1/4⅛	1/4⅛	Do. 7 p.c. Pref.	17/—19/-	...	...
609,204	1	Oct. 19	1/3·27	·/10·90	Colonial Gas Assn. Ltd. Ord.	10/—15/-	...	...
296,053	1	,,	1/5·67	1/2·54	Do. 8 p.c. Pref.	10/—15/-	...	...
2,079,280	Stk.	July 23	6	6	Commercial Ord.	91—94	−1	92½
475,000	,,	Dec. 14	3	3	Do. 3 p.c. Deb. ...	51—56	...	...
787,560	,,	Aug. 10	7	7	Croydon sliding scale ...	107—110	...	...
458,100	,,	,,	5	5	Do. max. div.	81—84	...	...
542,270	,,	Aug. 24	10	7	Derby Con.	120—125c	...	...
55,000	,,	Jan. 4	4	4	Do. Deb.	65—70c*	...	...
209,000	,,	Sept. 7	5	5	East Hull Ord. 5 p.c. ...	71—76	...	...
179,500	,,	Aug. 24	5½	5½	East Surrey Ord. 5 p.c. ...	86—91	...	...
155,019	,,	Jan. 4	5	5	Do. 5 p.c. Deb. ...	90—95	+2	...
1,002,180	,,	Sept. 21	16½	14	European, Ltd.	103—113	+3	103—106½
18,953,033	,,	July 23	5⅝	5⅝	Gas Light & Coke 4 p.c. Ord.	18/6—19/6f	...	18/9—19/3
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max. ...	53—58	...	56½—57½
4,294,691	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	70—75	...	73—73½
5,694,095	,,	Dec. 14	3	3	Do. 3 p.c. Con. Deb. ...	53—58	...	55½
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	93—98	...	96—98
2,500,000	,,	,,	—	4½	Do. 4½ p.c. Red. Deb. ...	84—89	...	86½—88½
161,480	,,	Sept. 7	10	10	Harrogate Cons. 10 p.c. max.	157—162	...	...
82,500	,,	Aug. 24	7	7	Hastings & St. L. 5 p.c. Conv.	95—100	...	...
258,740	,,	,,	5½	5½	Do. 3½ p.c. Conv.	81—86	...	85½—86
70,000	10	9 Oct. '30	½	10	Hongkong & China, Ltd. ...	12—13	...	...
213,200	Stk.	Aug. 10	6	6	Hornsey Con. 3½ p.c. ...	89—92	...	90—91
2,800,000	,,	Oct. 30	25	15	Imperial Continental Cap.	315—335	...	324—329
223,180	,,	Aug. 10	3½	3½	Do. 3½ p.c. Red. Deb.	70—75	...	...
235,242	,,	Aug. 10	8½	8½	Lea Bridge 5 p.c. Ord. ...	129—132	...	130—131
2,145,907	,,	Aug. 24	6	6	Liverpool 5 p.c. Ord. ...	97⅜—98⅜b	+½	...
306,083	,,	Jan. 15	4	4	Do. 4 p.c. Deb. ...	78—80b*	−1	...
165,736	,,	Aug. 24	9	8	Maidstone 5 p.c. Cap. ...	123—128	...	...
63,480	,,	Jan. 4	3	3	Do. 3 p.c. Deb. ...	51—56	−2	...
75,000	5	Nov. 30	†10	†10	Malta & Mediterranean ...	6½—7	...	...
392,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	78—83	...	...
171,978	Stk.	Aug. 24	5	5	M. S. D. Utility "C." Cons.	76—81	...	...
522,992	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	67—72	...	...
675,000	,,	May 21	†6	†6	Montevideo, Ltd.	70—80	...	...
2,061,315	,,	Aug. 10	5½	5	Newcastle & Gateshead Con.	16/—17/-d/	...	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	68—70d	...	...
691,705	,,	Jan. 4	3½	3½	Do. 3½ p.c. Deb. ...	68—70d	...	...
277,285	,,	Oct. 30	5	5	Do. 5 p.c. Red. Deb.	96—98d	...	...
199,940	,,	Aug. 24	7½	7½	North Middlesex 6 p.c. Con.	105—110	...	...
396,160	,,	Aug. 10	5	5	Northampton 5 p.c. max. ...	74—79	...	...
300,000	,,	Nov. 30	7	9	Oriental, Ltd.	88—98	...	...
60,000	5	13 May, '15	—	—	Ottoman	0—¼	...	...
205,162	Stk.	Jan. 4	8	8	Plym'th & Stonehouse 5 p.c.	114—119	+7	...
424,416	,,	Aug. 24	8	8	Portsm'th Con. Stk. 4 p.c. Std.	119—124	...	120
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	76—79	...	...
686,312	,,	Jan. 18	4	4	Primitiva 4 p.c. Rd. Db. 1911	75—85*	...	80—80½
389,813	,,	Jan. 4	4	4	Do. 4 p.c. Cons. Deb.	75—85	...	...
150,000	10	Sept. 21	6	6	San Paulo 6 p.c. Pref. ...	7½—8	...	...
1,736,968	Stk.	Sept. 7	6½	6	Sheffield Cons.	103—105e	...	...
95,000	,,	Jan. 18	4	4	Do. 4 p.c. Deb.	79—81e*	...	...
133,201	,,	Sept. 7	5	8½	Shrewsbury 5 p.c. Ord. ...	90—95	...	...
90,000	10	June 11	†5	†5	South African	3¼—5¼	...	...
6,709,895	Stk.	July 23	7½	5	South Met. Ord.	95—99	−1½	99½—100
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	103—108	...	105—106½
1,895,445	,,	Jan. 4	3	3	Do. 3 p.c. Deb. ...	52—57	...	54—56½
1,000,000	,,	Jan. 18	4	5	Do. 5 p.c. Red. Deb.	93—98*	−½	...
91,500	,,	Aug. 10	8½	8½	South Shields Con.	108—110d	...	...
1,543,795	,,	Aug. 10	6½	6½	South Suburban Ord. 5 p.c.	102—105	...	103
668,837	,,	Jan. 4	5	5	Do. 5 p.c. Deb.	90—95	...	93—95
647,740	,,	Aug. 24	5	5	Southampt'n Ord. 5 p.c. max.	77—80	...	79
121,275	,,	Jan. 4	4	4	Do. 4 p.c. Deb.	70—75	+2	...
250,000	,,	Aug. 24	7	7	Swansea 7 p.c. Red. Pref. ...	96—99	...	...
200,000	,,	Jan. 4	6½	6½	Do. 6½ p.c. Red. Deb.	98—101	...	...
1,076,490	,,	Aug. 10	6⅝	6⅝	Tottenham and District Ord.	103—107	...	...
150,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	93—98	...	...
199,005	,,	Dec. 14	4	4	Do. 4 p.c. Deb. ...	71—76	+3	74—75
85,701	,,	Sept. 21	6	6	Tuscan, Ltd., 6 p.c. Red. Db.	72—77	...	...
510,694	,,	Aug. 24	7	7	Uxbridge, Maidenhead, & Wycombe 5 p.c.	100—105	...	...
88,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	85—90	...	...
1,322,220	,,	July 9	7	7	Wandsworth and District: Consolidated	110—114	...	110
971,373	,,	,,	5	5	Do. 5 p.c. Pref.	89—94	...	...
1,167,964	,,	Jan. 4	5	5	Do. 5 p.c. Deb.	90—95	...	93½

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of stock. * Ex. div. † Paid free of income-tax. ‡ For year. ½ Div. = 10 p.ct. p.a. less tax and less tax on interim dividend

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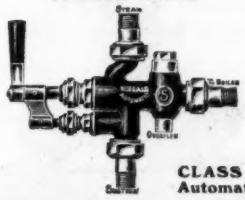
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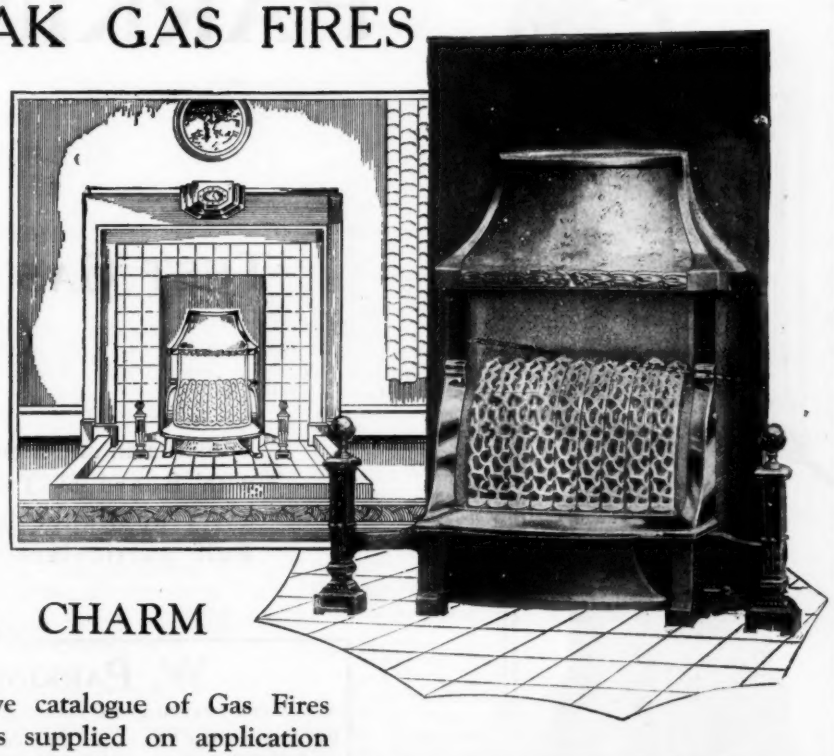

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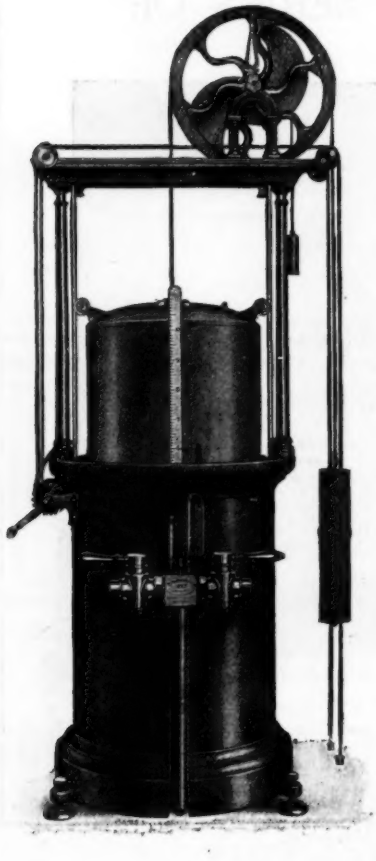

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